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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

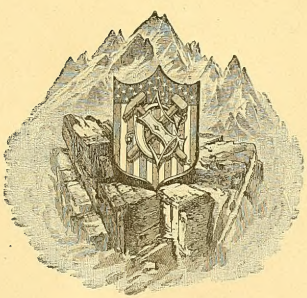
THE CRETACEOUS FLORA

OF

SOUTHERN NEW YORK AND NEW ENGLAND

BY

ARTHUR HOLLICK



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THE CRETACEOUS FLORA
OF
SOUTHERN NEW YORK AND NEW ENGLAND.

By Arthur Hollick.

INTRODUCTION.

SCOPE OF THIS MONOGRAPH.

The flora described in this monograph belongs in part to the Raritan and in part to the Cliffwood formation of the Atlantic Coastal Plain Cretaceous, as represented in southern New York, on Staten Island and Long Island, and in southern New England, on Block Island and Marthas Vineyard in the States of Rhode Island and Massachusetts, respectively, and these formations within the above-described geographic limits are collectively the equivalent of the "Island series" of Dr. Lester F. Ward, as defined by him in his paper on the Potomac formation[a] (pp. 335, 336) as follows:

> From Morgan [N. J.], the most easterly point, the formation may be traced northward across Staten Island and the northern shore of Long Island, and it reappears on Marthas Vineyard in the celebrated cliffs of Gay Head. At all of these points the stratigraphical evidence is strongly supported by paleontological evidence. Along this most eastern line a new phase is seen, viz, the occurrence of concretions in the variegated clays, in the form of hard ironstones, which when broken open are often found to contain vegetable remains in an admirable state of preservation. I am therefore disposed to regard these ferruginous, concretionary beds, extending from Staten Island to Marthas Vineyard, as the very latest phase of the Potomac formation, which I shall call the Island series, although from the similarity in the flora I am disposed to include them, along with the Raritan and Amboy clays, in the Albirupean series.

Since the date when the above was written, our knowledge of the geology of the region has been considerably enlarged by the discovery of new exposures and by the critical examination and identification of the paleontological material collected, so that we are now in a position to define with reasonable certainty the present and probable former areal extent of the deposits of Cretaceous age in the region and to correlate them more satisfactorily than heretofore with equivalent deposits elsewhere. In this connection the evidence derived from fossil plants has been of greatest value, and these it is the special object of this monograph to describe and discuss.

[a] Fifteenth Ann. Rept. U. S. Geol. Survey (1893-94), 1895, pp. 307-397.

LOCALITIES WHERE FOSSIL PLANTS HAVE BEEN FOUND.

Within the areal limits of the islands mentioned a number of localities have yielded fossil plants. At some they were found in place in the clays; at others, as morainal material more or less closely associated with them, as will be described more fully in the geological discussion.

Following is a list of the localities, with the characters of the plant-bearing deposits:

Staten Island:
- Green Ridge, clays in place.
- Kreischerville, clays in place.
- Tottenville, morainal material.
- Richmond Valley, morainal material.
- Princess Bay, morainal material.
- Arrochar, morainal material.

Long Island:
- Brooklyn, morainal material.
- Elm Point (Great Neck), clays in place?
- Mott Point (Manhasset Neck), morainal material.
- Sea Cliff, morainal material.
- Glen Cove, clays in place and morainal material.
- Dosoris Island, morainal material.
- Oak Neck, morainal material.
- Center Island, morainal material.
- Cold Spring, clays in place.
- Lloyd Neck, morainal material.
- Little Neck (Northport Harbor), clays in place.
- Eatons Neck, morainal material.
- Montauk Point, morainal material.

Block Island:
- Black Rock Point, morainal material.
- Southeast Point, morainal material.
- Balls Point, morainal material.

Marthas Vineyard:
- Gay Head, clays disturbed by glacial action and morainal material.
- Nashaquitsa, clays disturbed by glacial action.
- Chappaquiddick, morainal material redistributed.

Elizabeth Islands:
- Naushon, morainal material.

PREVIOUS DESCRIPTIONS AND STUDIES OF THE REGION.

The region included within the scope of this monograph attracted the attention of geologists and others interested in natural phenomena before the beginning of the last century. The earlier scientific descriptions consist for the most part of narratives of explorations, with references to facts observed and conclusions deduced from them, which although they sound crude and quaint to-day are of interest and value in reflecting the habit of mind which prevailed at the time they were written, and when read in connection with later investigations and interpretations form an instructive chapter in the evolution of scientific observation and reasoning.

In 1786 Rev. Samuel West, William Baylies, and four others formed a party to visit Marthas Vineyard, and the account of their voyage and what they observed was

included in two communications to Governor James Bowdoin, of Massachusetts,[a] from which the following by Mr. Baylies is abstracted:

I have at length executed the design, which I had formed in consequence of an invitation from the Reverend Mr. West, of visiting Gay Head. In company with him, Col. Pope, and two others I sailed from Bedford in an open two-mast boat. * * * A northerly wind carried us down the river into the midst of the bay in an easy, agreeable manner. A calm then coming on with a hot sun and a constant rolling of the boat, I grew exceedingly sick. Nothing could alleviate my feelings but a view of Gay Head, through Quicks Hole, at the distance of about fifteen miles. A variety of colors, such as red, yellow, and white, differently shaded and combined, exhibited a scene sufficient to captivate the mind, however distressed. * * * We beckoned to two young Indians whom we saw on the hills above us. They immediately came, and by the promise of a little rum our boat was hauled up on the beach. * * * After our arrival at the cliffs we looked round for a place of descent. This in a little time we found. * * * On one side we had a red, unctuous, argillaceous earth; on the other a blue, white, and yellow one variegated with gray, black, and green spots, and masses of charcoal under our feet. When we had descended, on looking back the idea of a volcano struck us at once. In fact, it had all the appearance of having blown out but a few days. That it was formerly a volcano was confirmed by a further examination. Large stones whose surfaces were vitrified, great numbers of small ones cemented together by melted sand, and also cinders were to be seen in many places. A black, sooty powder similar to lampblack and made use of by painters to serve the same purposes, under which a whitish matter resembling the gypseous earth calcined, intermixed with the same kind of earth uncalcined, were to be found in great quantities. Besides there are very plain marks of four or five different craters. * * * We tarried on the island * * * examining the cliffs. * * * They appeared to be composed principally of clays of all colors and unctuous to the touch. The red, used as a paint, undoubtedly derives its color from the calx of iron. The blue shoots out copperas in considerable plenty, and we found hard, heavy pieces of matter sparkling with small granulated particles of a white color embedded therein. This, it is probable, will afford something of the metallic kind. * * * Small streams of water ran down the sides of the cliffs. * * * Every one of these had more or less of the vitriolic taste.

The bones of whales, sharks' teeth, and petrified shellfish are frequently picked up, scattered up and down the cliff, at a considerable distance above the surface of the water. The sea, it is said, has made considerable encroachments on this part of Gay Head. Within thirty years it has swept off fifteen or twenty rods. Had Neptune thus demolished part of Vesuvius or Ætna up to their very craters and laid open all their secrets, how would the curious in Europe have flocked from all quarters to behold a scene so full of wonders! But Gay Head is scarcely mentioned in America.

Probably the next description of importance relating to any portion of the region is that by Dr. Samuel L. Mitchill, in which the author discusses the geology and mineralogy of "Long or Nassau Island:"[b] His statements of facts and his theories in regard to them make curious reading for the modern geologist, and in places may be detected a note of protest against the new ideas of cause and effect that were just then beginning to be accepted. In his speculations concerning the geology, for example, he says:

From a survey of the fossils in these parts of the American coast, one becomes convinced that the principal share of them is granitical, *composed of the same sorts of materials as the highest Alps, Pyrenees, Caucasus, and Andes, and, like them, destitute of metals and petrifactions.*

The occurrence of *no* horizontal strata, and the frequency of vertical layers, led him further to suppose *that these strata are not secondary collections of minerals, but are certainly in a state of primeval arrangement.* * * *

What inference remains now to be drawn from this statement of facts, but that the fashionable opinion of considering those maritime parts of our country as flats, hove up from the deeps by the sea or brought down from the heights by the rivers, stands unsupported by reason and contradicted by experience?

[a] Mem. Am. Acad. Arts and Sci., vol. 2, pt. 1, 1793, pp. 147–150; ibid., 1797, pp. 150–155.
[b] Medical Repository, vol. 3, 2d ed., 1805, pp. 325–335; vol. 5, 1802, pp. 212–215.

Nevertheless he gives evidence further on of accurate powers of observation and an ability to draw conclusions from facts which would do credit to modern investigators. Thus in discussing the formation of Long Island he continues:

> A more probable opinion is, that Long Island and the adjacent continent were, in former days, contiguous, or only separated by a small river, and that the strait which now divides them was formed by successive inroads of the sea, from the eastward and westward, in the course of ages. * * *
>
> Between Long Island and the continent there are several shoals, with rocks scattered over them, which are apparently *sunken* or wasted islands. These remains of what was, probably, in former days, upland of as great height as the neighboring islands afford strong evidence of the leveling power of the waves.

Nearly all who subsequently investigated the geology of the region recognized that the extensions of the Coastal Plain strata of the mainland were probably represented on Staten Island, Long Island, and the islands to the eastward, but at first with poorly defined or erroneous conceptions of their geologic age or stratigraphic relations.

In 1823 John Finch read a paper before the Academy of Natural Sciences of Philadelphia, entitled "Geological Essay on the Tertiary Formation in America,"[a] in which the Raritan, Staten Island, Long Island, and Gay Head clays are referred to the Tertiary period.

In 1824 Edward Hitchcock, in his "Notices on the Geology of Marthas Vineyard and the Elizabeth Islands,"[b] remarks that "Long Island, in those places where I have seen it, is unquestionably very similar in its geological structure to Marthas Vineyard, and probably belongs to the same era," while further on he concludes "that the Vineyard and Nantucket are the continuation of that extensive formation, hitherto called Alluvial, of which Long Island has been regarded as the north-eastern limit."

About 1825 the studies of Lardner Vanuxem and S. G. Morton resulted in an effort to differentiate the late formations of eastern United States, and in a paper by the latter entitled "Geological Observations on the Secondary, Tertiary, and Alluvial Formations of the Atlantic Coast of the United States of America,[c] he mentions Manhattan Island, Long Island, Marthas Vineyard, and Nantucket as included in the Tertiary, although the equivalency of certain of the New Jersey strata with the Cretaceous of the Old World is recognized.

In 1837 and 1838 William W. Mather, in the First and Second Annual Reports of the New York State Geological Survey,[d] mentions the clays and sands of Staten Island and Long Island, but with very indefinite allusions to their probable geological relations. In regard to the Staten Island exposure he merely says that it seems to be "similar in its general characters to that of Cheesequake and Matavan Point, on the Jersey shore, and it appears to have a similar geological position;" while in regard to the clays of Long Island he remarks that "they have the external characters of potter's clay," but he refers them to the Tertiary.

In 1843, in his final report,[e] Mr. Mather arrives at more definite conclusions in regard to the last-mentioned strata and says:

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[a] Am. Jour. Sci., vol. 7, 1824, pp. 31–43.
[b] Ibid., pp. 240–248.
[c] Jour. Acad. Nat. Sci. Philadelphia, vol. 6, pt. 1, 1827, pp. 59–71.
[d] Assembly Doc. No. 161, February 11, 1837; ibid., No. 200, February 20, 1838.
[e] Nat. Hist. New York, pt., 4; Geol., pt. 1; Geol. 1st Geol. Dist., p. 248.

The reasons for believing that the principal mass of this formation is older than the Tertiary will be seen in tracing the equivalency of these beds to those of New Jersey, Maryland, Delaware, and Virginia, where it is considered as established that the corresponding strata belong to the upper secondary of the epoch of the Cretaceous and greensand formations.

Up to this time, while the general relationships between the strata of the mainland coastal plain and those of the islands were recognized, this recognition was based upon lithologic resemblances and stratigraphic position only, and, in the absence of any paleontologic evidence, conclusions were not entirely satisfactory or convincing and more or less controversy and discussion ensued.

At about this period, however, the first discoveries of fossils on the islands began to be made, but their importance was not appreciated. The discoveries were not followed up, and they received but little more than passing attention. Probably the earliest record in this connection is by Edward Hitchcock[a] in his descriptions of and discussion concerning the fossil animal and vegetable remains found at Gay Head. Of special significance are the fossil fruit and leaves, to some of which reference is made in this monograph.[b] The Gay Head section is included by the author under "Eocene or older Tertiary strata."

On December 19, 1842, at a meeting of the New York Lyceum of Natural History, a specimen of *Exogyra* was shown, to which the following reference may be found in the minutes of that meeting: "Doctor Jay exhibited a fossil *Exogyra*, found 60 feet below the surface, in digging a well in the city of Brooklyn. Referred to Messrs. Jay and W. C. Redfield to report upon the authenticity of the locality and other matters respecting the geological relations of the fossil." This discovery was again mentioned at the Albany meeting of the Association of American Geologists and Naturalists, in 1843, by Mr. Redfield, who said:[c] "This is believed to be the first authentic memorial of the Cretaceous formation found in the State of New York." It may also be found mentioned by Issachar Cozzens, jr., on pp. 51, 52 of his "Geological History of Manhattan or New York Island, etc.," published in 1843, where he says in his discussion of the New Jersey marl: "It is more than probable that this member of the Cretaceous Group underlies Long Island and may be a continuation of the great range which begins at the south, in Virginia, and runs through New Jersey to the Neversink Hills, at which place it is last seen above the surface." Accompanying this discussion is a theoretical geological section (pl. 3), drawn in the exaggerated manner characteristic of that time, which is exceedingly interesting when viewed in the light of what we now know in regard to the structure of Long Island.

In 1849 a paper was published by M. E. Desor and E. C. Cabot under the title "On the Tertiary and More Recent Deposits in the Island of Nantucket,"[d] in which the authors refer to the resemblance between the clays of Truro, Cape Cod; Sankaty Head, Nantucket, and Gay Head, Marthas Vineyard, all of which are regarded as probably Tertiary in age and as extending to the south beneath Long Island.

[a] Final Rept. Geol. Mass., vol. 2, 1841, pp. 429–433.
[b] *Dammara borealis* Heer, p. 37, Pl. II, figs. 12, 21. *Magnolia auriculata* Newb., p. 68, Pl. XX, fig. 8.
[c] Abstr. Proc. 4th sess., Assn. Am. Geol. and Nat.: Am. Jour. Sci., vol. 45, 1843, p. 156.
[d] Quart. Jour. Geol. Soc. London, vol. 5, 1849, pp. 340–344.

In 1859 Dr. William Stimpson visited Marthas Vineyard, where he collected both animal and plant remains and determined certain of the strata at Gay Head to be Cretaceous in age.[a] The notice in regard to this excursion, however, is very meager.

The work of the Geological Survey of New Jersey, which was begun at about this time, contributed a constantly increasing amount of information from year to year, in its annual reports, concerning the Cretaceous deposits in that State, together with occasional references to their probable extensions through Staten Island and Long Island, affording material assistance to those who were engaged in the study of these deposits on the islands mentioned.

In 1873 a geological map of the United States, prepared by C. H. Hitchcock and W. P. Blake, was issued in connection with the Ninth United States Census. On it the north shore of Long Island was indicated as Cretaceous, and in reply to a criticism of this feature by J. D. Dana[b] a paper was read by Professor Hitchcock before the American Association for the Advancement of Science at the Portland, Me., meeting in 1873, in which he says:[c] "Notwithstanding the evidence is so probable in its favor, it is surprising to observe that mine is the first published map that colors this area correctly."

This discussion, however, practically ended any further serious controversy in regard to the Cretaceous age of the Long Island strata. Evidence began to accumulate which could no longer be ignored or controverted, and writers became more conservative in expressing contrary opinions or conclusions. Specimens of dicotyledonous leaves were found at several widely separated localities on Long Island, and although their exact geological age was not at first determined their significance was appreciated.

The earliest record in this connection is probably to be found in the Proceedings of the New York Lyceum of Natural History,[d] in the account of the meeting of January 9, 1871, where the following brief paragraph occurs:

> The president, Dr. J. S. Newberry, exhibited a piece of red sandstone, containing impressions of leaves found in excavating the foundation for the gas office in Williamsburg [now included in the eastern district of Brooklyn]. This, he said, was a specimen of remarkable interest. In its lithological characters this rock closely resembles the Triassic sandstone so much used in New York for architectural purposes; but *it contained numbers of very beautifully preserved impressions of angiospermous leaves.* No plants of this kind were known to exist during the Trias or before the Cretaceous; but we know of no such Cretaceous or Tertiary sandstone on the North American continent. The mass from which this specimen was taken was a bowlder and the associated transported blocks were granite, porphyry, greenstone, dolomite, etc., plainly referable to well-known localities north of New York. But no such sandstone as this was known, and it became a matter of extreme interest to ascertain what was its origin.

Subsequently further material was brought to light, and at the meeting of March 23, 1874, as recorded in the Proceedings (ser. 2, No. 4, pp. 126, 127), it was reported upon as follows:

> The president [Dr. J. S. Newberry] described a sandstone containing angiospermous leaves very similar in aspect to those of the Raritan and of the Lower Cretaceous in the far West, which occurs in bowlders at Lloyds Neck, Long Island. This is undoubtedly the same rock with that of the Williamsburg gas house, as he was satisfied from comparison. It is totally unlike anything known in this vicinity, and unfortunately has not yet been found in situ. Whenever it is, some interesting light will be thrown on this whole question. But its presence under these circumstances points to its existence in place at some locality not far away.

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[a] Am. Jour. Sci., vol. 29, 1860, p. 145.
[b] Am. Jour. Sci., vol. 6, 1873, p. 66.
[c] Proc. Am. Assn. Adv. Sci., vol. 22, pt. 2, 1874, pp. 131, 132.
[d] Ser. 1, pp. 149, 150.

In 1879 Mr. Warren Upham published his papers on "Terminal Moraines of the North American Ice Sheet,"[a] in which may be found the first comprehensive effort to discuss the most obvious glacial phenomena of the coastal islands, with incidental reference to the basal clays and their contorted condition in a number of localities. In regard to the clays on Gardiners Island he says (p. 90): "Further exploration is needed to compare these with the lignitic beds of Block Island and the upturned Tertiary strata of Gay Head."

In 1881 Dr. N. L. Britton read a paper before the New York Academy of Sciences entitled "On the Geology of Richmond County, N. Y.,"[b] in which the probable eastward extension of the Cretaceous strata through Staten Island and Long Island is mentioned and the prediction is made that although "no fossil leaves or shells have been taken from the clays of Staten Island * * * it is not improbable that they will be found at some future time, when the excavations are more advanced than at present."

In the same year the Natural Science Association of Staten Island[c] was organized and the investigation of local scientific matters was systematized, and the collecting of material and recording of facts was begun. In the Proceedings of this association for November 10, 1883, may be found a paragraph to the effect that—

* * * the following objects were presented and discussed: By Mr. Hollick, fossil leaf impressions * * * from the shale and sandstone on the shore at Tottenville. Mr. Britton spoke at some length in regard to this discovery and stated that it was likely to prove the most important one yet made by the association. Geologically it is a link in the chain connecting Glen Cove, Long Island, with Keyport, N. J., at each of which localities similar fossils have been found. The age of the rocks containing them is a matter of dispute, some authorities referring them to the Cretaceous and some to the Tertiary. It is quite possible that a careful study and investigation of our locality may be of far more than mere local importance.

In the Proceedings of the same association for December 8, 1883, the matter is again referred to in the following communication by Doctor Britton:

The occurrence of similar fossiliferous sandstones on the beach near Glen Cove, Long Island, and vicinity has been known for some time. There they are found in precisely the same position as at Tottenville, and are associated with extensive beds of fire clay, kaolin, etc. The Tottenville station is not immediately on these clays, but they are found near by in several directions, notably at Kreischerville. That the two localities mark outcrops of the same geological formation, and probably approximately of the same strata, is almost certain. The physical structure of the Glen Cove series is exactly parallel to that of certain of the clay beds of Middlesex County, N. J., which are well known to belong to the Cretaceous epoch. In the absence of sufficient fossil evidence we can not state with absolute certainty that the two deposits are equivalent, but there is little doubt that this will ultimately be proven and that the New Jersey and Staten Island clays, kaolins, lignites, etc., find another and their most northern outcrop on the north shore of Long Island at or near Glen Cove.

In 1885 plant remains were found in the Kreischerville clays as had been anticipated. A number of these were compared with and identified as known species common in the New Jersey Cretaceous clays, and the equivalency of the strata in the two localities was definitely established.[d]

In the meantime Mr. F. J. H. Merrill had been at work on the geology of Long Island, and the results of his investigations were included in a paper on the subject,

[a] Am. Jour. Sci., vol. 18, 1879, pp. 81–92, 197–209.
[b] Annals New York Acad. Sci., vol. 2, 1882, pp. 161–182.
[c] Now the Staten Island Association of Arts and Sciences.
[d] Proc. Nat. Sci. Assn. Staten Island, vol. 1, February 13, 1886, p. 31

read before the New York Academy of Sciences on November 7, 1884;[a] but the author assumed a very conservative attitude in regard to the presence of any member of the Cretaceous series and merely concluded that—

> From the position and strike of the Cretaceous strata in New Jersey and Staten Island it has been surmised by geologists that they underlie Long Island throughout the whole or a portion of its extent. The locality at which the strata most resemble the Cretaceous beds of New Jersey is Glen Cove, where the clays already described are probably of this age.

During this same period Dr. J. S. Newberry began his studies of the Amboy clay flora of New Jersey, by means of which he was enabled to correlate these clays with the Dakota group of the West and the lower Atane beds of Greenland and also to determine certain of the fossil leaves found on Long Island to be specifically identical with those from the Amboy clays and thus to fix beyond further question the Cretaceous age of the clays of Long Island. The complete results of Doctor Newberry's investigations were not published until many years subsequently,[b] but I enjoyed the benefit of close association with the author in the preparation of both the manuscript and the plates and in the collecting of material from the first inception of the work. Doctor Newberry's conclusions in regard to the Cretaceous age of the strata within the island areas and their correlation as above noted may be found discussed in the introductory chapter of the work mentioned.

At a meeting of the New York Academy of Sciences, on May 11, 1885, Dr. F. J. H. Merrill gave a description of the beds at Gay Head, Marthas Vineyard, referring them to the post-Pliocene or Quaternary,[c] but the record consists merely of the title of the paper read.

In 1888 a report on the geology of Marthas Vineyard, by Prof. N. S. Shaler, appeared,[d] and, in the following year, one on Nantucket by the same author.[e] Both Cretaceous and Tertiary strata were recognized as present on the former, but only Tertiary and more recent on the latter. These were by far the most comprehensive works on any of the coastal islands which had been published up to that time, and while all of the author's deductions may not have stood the test of later discoveries, they mark an epoch in the investigation of the geology of the region and the beginning of careful and painstaking work on a modern scientific basis. In 1889 the same author published a paper "On the Occurrence of Fossils of the Cretaceous Age on the Island of Marthas Vineyard, Mass.,"[f] in which is described a limited fauna, but no flora.

Even in the light of all the evidence above outlined, however, the presence of Cretaceous strata throughout the coastal islands was not universally conceded. In 1886, on a geological map of the United States by Prof. C. H. Hitchcock, published in connection with the American Institute of Mining Engineers, the Cretaceous is not indicated on Marthas Vineyard, although it is indicated on the north shore of Long Island; and as late as 1891, in "Correlation Papers—Cretaceous,"[g] Dr. C. A. White remarks (p. 85) that: "Several persons have written upon, or referred to, the

[a] Annals New York Acad. Sci., vol. 3, 1885, pp. 341–364.

[b] Flora of the Amboy clays, by J. S. Newberry; a posthumous work, edited by Arthur Hollick: Mon. U. S. Geol. Survey, vol. 26, 1895 (1896).

[c] Trans. New York Acad. Sci., vol. 4, 1885 (1887), pp. 78, 79.

[d] Seventh Ann. Rept. U. S. Geol. Survey, 1885–6 (1888), pp. 297–363.

[e] Bull. U. S. Geol. Survey No. 53, 1889.

[f] Bull. Mus. Comp. Zool. Harvard Univ., vol. 16, 1889, pp. 89–97.

[g] Bull. U. S. Geol. Survey No. 82, 1891.

discovery of Cretaceous fossils upon Long Island; but a large proportion of these reported discoveries lack confirmation."

It was about this time that the work which finally resulted in the preparation of this monograph may be said to have had its inception, although for several years previously I had been engaged in the investigation of the Cretaceous strata on Staten Island, the results of which were recorded from time to time in the Proceedings of the Natural Science Association of Staten Island. During the years 1889 and 1890 Mr. David White and Mr. Lester F. Ward made extensive collections of paleobotanical material on Long Island and Marthas Vineyard, which resulted in the publication of two papers on the subject by Mr. White.[a] These papers demonstrated so conclusively the importance of fossil plants as paleontological evidence that the prosecution of this line of investigation was clearly indicated as indispensable in the event of any comprehensive investigation of the geology of the region being attempted. This material was shortly afterwards turned over to me for critical examination and report, but it at once became apparent that any such work would lack completeness unless it could be made to include a study of all the coastal islands and the adjacent shores. In accordance with this idea a systematic exploration was at once begun, beginning at Staten Island and extending eastward through Long Island, Block Island, Marthas Vineyard, Nantucket, the Elizabeth Islands, and Cape Cod. The results of this exploration, which was carried on from year to year as circumstances permitted, were included in a series of papers, most of which were read before the New York Academy of Sciences or the Torrey Botanical Club, and subsequently published in the Transactions or Annals of the former and the Bulletin of the latter and of the New York Botanical Garden.[b] The facts recorded in these papers form the basis of this monograph, and in it is included all that seems to be essential to its scope as previously defined.

[a] Am. Jour. Sci., vol. 39, 1890, pp. 93–101; Bull. Geol. Soc. Am., vol. 1, 1890, pp. 554, 555.

[b] I. The paleontology of the Cretaceous formation on Staten Island: Trans. New York Acad. Sci., vol. 11 (February 29, 1892), pp. 96–104, pls. 1–4.

II. Additions to the paleobotany of the Cretaceous formation on Staten Island: Trans. New York Acad. Sci., vol. 12 (November 14, 1892), pp. 28–39, pls. 1–4.

III. Additions to the paleobotany of the Cretaceous formation on Staten Island, No. 2: Annals New York Acad. Sci., vol. 11 (October 13, 1898), pp. 415–430, pls. 36–38.

IV. Some features of the drift on Staten Island, N. Y.: Annals New York Acad. Sci., vol. 12 (July 7, 1899), pp. 91–102, pl. 1.

V. Plant distribution as a factor in the interpretation of geological phenomena, with special reference to Long Island and vicinity: Trans. New York Acad. Sci., vol. 12 (April 24, 1893), pp. 189–202.

VI. Preliminary contribution to our knowledge of the Cretaceous formation on Long Island and eastward: Trans. New York Acad. Sci., vol. 12 (May 22, 1893), pp. 222–237, pls. 5–7.

VII. Additions to the paleobotany of the Cretaceous formation on Long Island: Bull. Torrey Bot. Club, vol. 21 (February 20, 1894), pp. 49–65, pls. 174–180.

VIII. Additions to the paleobotany of the Cretaceous formation on Long Island, No. 2: Bull. New York Bot. Gard., vol. 3 (April 14, 1905), pp. 403–418, pls. 70–79.

IX. Some further notes on the geology of the north shore of Long Island: Trans. New York Acad. Sci., vol. 13 (January 22, 1894), pp. 122–130, and table of distribution.

X. Geological notes: Long Island and Nantucket: Trans. New York Acad. Sci., vol. 15 (October 14, 1895), pp. 3–10.

XI. Geological notes: Long Island and Block Island: Trans. New York Acad. Sci., vol. 16 (October 19, 1896), pp. 9–18.

XII. Notes on Block Island: Annals New York Acad. Sci., vol. 11 (April 20, 1898), pp. 55–88, pls. 2–9.

XIII. Observations on the geology and botany of Marthas Vineyard: Trans. New York Acad. Sci., vol. 13 (October 23, 1893), pp. 8–22.

XIV. Dislocations in certain portions of the Atlantic Coastal Plain strata and their probable causes: Trans. New York Acad. Sci., vol. 14 (October 15, 1894), pp. 8–20, figs. 1–5.

XV. A reconnaissance of the Elizabeth Islands: Annals New York Acad. Sci., vol. 13 (January 14, 1901), pp. 387–418, pls. 8–15.

XVI. Geological and botanical notes: Cape Cod and Chappaquiddick Island, Mass.: Bull. New York Bot. Gard., vol. 2 (April 25, 1902), pp. 381–407, pls. 40, 41.

During this same period other investigators were also at work in the same region, with most of whom I had the good fortune either to cooperate or to exchange views, and to whom I am indebted for valuable hints and material assistance on many occasions.

In 1892 Mr. P. R. Uhler published a paper entitled "A Study of Gay Head, Marthas Vineyard,"[a] in which is mentioned the occurrence of fossil leaves, including *Sapindus, Eucalyptus Geinitzi* Heer, *Liriodendron simplex* Newb., *Sequoia ambigua* Heer, and a *Sassafras*, which are described as having been found "in the layers of the alternating clay on both the west and the southwest faces of the Gay Head cliffs." The author also remarks (pp. 210, 211) that "The structure of the Gay Head terrane admits of no explanation as the result of mountain-building movements. * * * Such an enormous load of heavy material, accompanied by the thrust and pressure of icebergs driven over the surface and stranded at intervals, even if an extended glacier did not exert its energy upon this weakly consolidated elevation, might well have disturbed the poise of its upper beds. * * * " This same theory had been previously advanced by Dr. F. J. H. Merrill, in order to account for the contortions in certain strata on Long Island,[b] and similar phenomena on Block Island and Staten Island were subsequently referred to the same cause by me in the papers upon the geology of those islands, mentioned in the preceding list.

In a paper entitled "Notes on the Clays of New York State and their Economic Value"[c] Mr. Heinrich Ries briefly mentions the Staten Island and Long Island clays. In regard to the former he says (p. 43): "The clays of Staten Island are chiefly Cretaceous, as proven by the fossils found in them. * * * The chief outcrops are at Kreischerville, Green Ridge, and Arrochar. * * * In many instances the clays have been much disturbed by the passage of the ice over them, and in some cases the sections show overthrown anticlines. * * * Fragmentary plant remains were found by the writer." On Long Island he mentions the occurrence of clay, "no doubt of Cretaceous age," at Elm Point and remarks that leaves are said to have been found in it, while in regard to the Glen Cove outcrop he says (p. 45): "This has long been known to be Cretaceous, as proved by its contained plant remains, which are in concretions in the clay." The Northport clays are given the following brief description only (p. 45): "There is a deposit of fire and pottery clay at Northport. It is of white, blue, and red color and is stratified. The layers are separated by thin sheets of sand. The owner claims to have frequently dug up leaves. This is probably another Cretaceous outcrop."

In a subsequent paper by Mr. Ries on "Microscopic Organisms in the Clays of New York State"[d] the author says (p. 166): "A number of Cretaceous plant remains embedded in concretions have been found along the north shore of the island between Glen Cove and Northport, but they have been found in the clay only at the former locality. The writer has found leaves (referable to *Eucalyptus*) in the clays at Northport. * * * " In this paper a number of species of diatoms are listed as occurring in the Cretaceous clays, as follows (p. 167): "In that from Northport, which greatly resembles some of the Staten Island clays and may prove to be of the

[a] Trans. Maryland Acad. Sci., vol. 1, 1892 (1901), pp. 204–212.
[b] Annals New York Acad. Sci., vol. 3, 1885, pp. 358–360.
[c] Trans. New York Acad. Sci., vol. 12, 1892, pp. 40–47.
[d] Trans. New York Acad. Sci., vol. 13, 1894, pp. 165–169.

same age, three species of diatoms were met, viz: *Melosira granulata* (Ehr.) Ralfs., *Diatoma hyemale* K. B., *Cocconema parvum* W. Smith. * * * The most interesting discovery, however, was the finding of diatoms in the stoneware clay at Glen Cove. The species are: *Melosira granulata* (Ehr.) Ralfs. [and] *Stephanodiscus niagaræ* Ehr. .* * * "

In a bed of diatomaceous earth on Lloyd Neck the following diatoms were found (p. 168):

Melosira granulata (Ehr.) Ralfs.
Stephanodiscus niagaræ Ehr.
Epithemia turgida (Ehr.) Kutz.
Encyonema ventricosum Kutz.
Cymbella delicatula Kutz.
Cymbella cuspidata Kutz.
Navicula viridis Kutz.
Navicula cocconeiformis Greg.
Navicula major Kutz.
Navicula varians Greg.
Navicula lata Breb.
Eunotia monodon Ehr.
Gomphonema capitatum Ehr.
Stauroneis Phœnecenteron Ehr.
Fragilaria construans Grun.
Synedra affinis K. B.
Campyloneis Grevillei regalis.
Triceratium trifoliatum.

The author does not make it clear, however, whether he regards the bed as Cretaceous in age, although this is inferred from the text. His final words are (p. 169):

> In the kaolin found near Kreischerville [Staten Island] were discovered a number of diatoms, which Dr. [D. B.] Ward informs me are either *Cocconeis placentula* Ehr. or *Cocconeis pediculus* Ehr. Their occurrence is also of great interest, as these kaolins are known to be middle Cretaceous beyond doubt.
>
> It seems to me that the results obtained from this hasty examination of the clays are sufficiently encouraging to warrant a further and detailed search. The correlation of strata by means of their microscopic organisms has been successfully tried elsewhere, and further work might prove it applicable to the clays of Long Island, whose age and stratigraphic relations need much further elucidation.

The Northport clays were subsequently submitted to a more critical examination by Mr. Ries, and a number of plant remains were found in them. These were submitted to me for study, and among them I was able to identify, provisionally, *Paliurus integrifolius* Hollick, *Laurus angusta* Heer, *Proteoides daphnogenoides* Heer, *Paliurus* sp., *Myrsine* sp., *Celastrophyllum* sp., and *Williamsonia* sp. This list, together with Mr. Ries's remarks on the clays, is included in his paper "On the Occurrence of Cretaceous Clays at Northport, Long Island,"[a] in which he says:

> In a previous paper the writer mentioned this clay deposit and expressed the belief that it would be found to be of Cretaceous age. Such has proven to be the case. In a recent visit to the locality a careful examination of the section exposed showed that a brownish-black seam of the clay, two feet thick, contained plant fragments in great quantity, and a few of them were sufficiently well preserved to permit identification and prove the Cretaceous age of the deposit beyond doubt.

All the facts included in these three papers by Mr. Ries were finally embodied in his "Clays of New York; their Properties and Uses,"[b] together with plates representing some of the exposures and others in which the diatoms and many of the characteristic Cretaceous leaves are depicted.

In 1894 Mr. Charles L. Pollard published a brief account of the Elm Point, Long Island, fossil leaf locality,[c] in which are enumerated the following four species: *Liriodendron simplex* Newb., *Diospyros primæva* Heer, *Magnolia alternans* Heer, and *Platanus Newberryana* Heer.

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[a] School of Mines Quart., vol. 15, 1894, pp. 353, 354.
[b] Bull. New York State Mus. No. 35, vol. 7, June, 1900, pp. 595–611.
[c] Trans. New York Acad. Sci., vol. 13, 1894, pp. 180, 181.

In 1895 Dr. F. J. H. Merrill published "Notes on the Geology of Block Island,"[a] in which he concludes that the white clays and sands exposed at certain localities may be of Cretaceous age and that their folded condition was caused by glacial action. In regard to the Clay Head deposit he remarks (pp. 17, 18) that "in character and position it is entirely analogous to that at Glen Cove, Long Island."

In 1896, at the New York meeting of the National Academy of Sciences, Prof. O. C. Marsh read a paper on "The Jurassic Formation on the Atlantic Coast,"[b] in which he advanced the theory that the clays throughout the insular area, as well as their equivalents in New Jersey, are probably Jurassic in age, but any evidence to support the theory was not produced.

This paper was supplementary to two preliminary papers by the same author, on "The Geology of Block Island,"[c] in which the same theory was advocated. In these contributions the opinion was expressed that the testimony of fossil plants was not conclusive as to the Cretaceous age of the strata.

In 1897 Prof. J. B. Woodworth read a paper before the Geological Society of America on "Unconformities of Marthas Vineyard and of Block Island,"[d] in which the disturbance caused by glacial action is discussed, and in 1900 one upon "Glacial Origin of Older Pleistocene in Gay Head Cliffs," etc.,[e] which may be regarded as supplementary to the one previously mentioned.

In 1899 a joint contribution appeared, by G. C. Curtis and J. B. Woodworth, entitled "Nantucket, A Morainal Island,"[f] in which, besides the discussion of the glacial deposits, there is a brief paragraph (p. 231 to) the effect that: "The oldest known formation on the island is a bluish clay, probably of Cretaceous age. * * * The beds of this series are highly folded, as are also the strata of the same, and even more recent date, in the islands westward to Staten Island." Opinions of others in regard to the causes of the folding are also given, but without discussion.

In 1905 Mr. Myron L. Fuller, in a paper on the "Geology of Fishers Island, New York,"[g] makes incidental reference to the same phenomena in connection with the Gay Head and Block Island clays. The occurrence of Cretaceous deposits, at a depth of some 260 feet below sea level, is inferred from the presence of a bed of blue clay struck at that depth in a well boring, in regard to which the author (p. 373) says: "No samples of this clay have been seen, but the fact that it rests on the granite instead of on a thick series of glacial gravels, as does the only known Pleistocene clay of the region, points to its probable Cretaceous age."

The most complete exposition of the geology of any part of the region was brought out in 1902, under the joint authorship of F. J. H. Merrill, N. H. Darton, Arthur Hollick, R. D. Salisbury, R. E. Dodge, Bailey Willis, and H. A. Pressey, as the New York City folio of the Survey,[h] in which the entire area of Staten Island and a portion of the adjacent area of Long Island is mapped topographically and geologically, with descriptive text and illustrations. The Cretaceous area of

[a] Trans. New York Acad. Sci., vol. 15, 1895, pp. 16–19.
[b] Am. Jour. Sci., ser. 4, vol. 2, 1896, pp. 433–447.
[c] Ibid., pp. 295–298, 375–377.
[d] Bull. Geol. Soc. Am., vol. 8, 1897, pp. 197–212.
[e] Bull. Geol. Soc. Am., vol. 11, 1900, pp. 455–460.
[f] Jour. Geol., vol. 7, 1899, pp. 226–236.
[g] Bull. Geol. Soc. Am., vol. 16, 1905, pp. 367–390.
[h] Description of the New York City district: Geologic Atlas U. S., folio 83, U. S. Geol. Survey, 1902.

Staten Island is defined both on the map and in the description, and is correlated with the Cretaceous of New Jersey on the basis of the fossil plants found in it.

About this time the problem of an additional water supply for New York City was receiving earnest attention, with the result that numerous investigations were made which involved reports upon the geology of areas from which such supplies might be obtained. Both Staten Island and Long Island received attention in this connection, and during the progress of the work several new facts were incidentally brought to light in relation to the surficial and underlying strata.[a]

Finally may be mentioned J. B. Woodworth's paper on the "Pleistocene Geology of Portions of Nassau County and Borough of Queens,"[b] in which the glacial phenomena of that area are described and illustrated in considerable detail.

In addition to the preceding references to the principal papers on the geology of the region a number of briefer notes and memoranda by some of the same authors and others could be given, but those quoted probably include essentially all of the diverse opinions which have been expressed from time to time, and indicate the necessity that existed for careful and critical examination of all the available facts in connection with the topographic features, stratigraphy, and paleontology of the region.

GEOLOGICAL DISCUSSION.

GENERAL CHARACTERISTICS OF THE PLANT-BEARING DEPOSITS.

The deposits in which fossil plants have been found at the localities previously mentioned consist, in part, of clays, sands, and gravels, lithologically similar to the Cretaceous strata of the mainland, as represented in the Raritan and Cliffwood formations of New Jersey, and, in part, of morainal material derived from them.

The occurrence of ferruginous shale and concretions, while not altogether absent on the mainland, reaches such a development on the islands as to constitute a distinct and characteristic lithologic feature of the insular deposits at a number of localities. The shaly condition is especially well developed in connection with the clay exposure on the shore a short distance west of the Glen Cove landing, Long Island, while the concretionary phase is best exemplified in the Gay Head section on Marthas Vineyard.

Both kinds of this hard material are also conspicuous constituents of the moraine throughout almost its entire insular extent, frequently containing plant remains and affording evidence of the former presence of Cretaceous deposits at or near to localities where all other indications have been entirely obliterated. It was the discovery of specimens of this kind that first indicated the existence of a Cretaceous flora in place on Staten Island and Long Island, and finally led to its identification elsewhere.

Whether this material is largely a result of glacial erosion and disturbance of the Cretaceous clays, which have thus become exposed to oxidizing influences and consequent

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[a] I. Freeman, John R., Report on New York's water supply, etc.; New York, Martin B. Brown & Co., 1900, 8 vo., pp. 587 maps, figures, and diagrams.

II. Crosby, W. O., Outline of the geology of Long Island in its relations to the public water supply: Tech. Quart. vol. 13, 1900, pp. 100–119.

III. Fuller, M. L., Probable pre-Kansan and Iowan deposits of Long Island, N. Y.: Am. Geol., vol. 32, 1903, pp. 308–312.

IV. Veatch, A. C., The diversity of the Glacial period on Long Island: Jour. Geol., vol. 11, 1903, pp. 762–776.

V. Veatch, A. C., and others, Underground water resources of Long Island, New York: Prof. Paper U. S. Geol. Survey No. 44, 1906.

[b] Bull. New York State Mus. No. 48. 1901.

hardening, is a question which has not as yet been satisfactorily answered. The coincidence of its abundance in connection with the moraine, or in Cretaceous beds more or less disturbed by glacial action, is significant, especially when compared with the relative rarity of similar material in equivalent undisturbed beds; and the fact that masses and fragments of clay may be found which show every gradation between the plastic condition and that of hard ferruginous shale or solid concretions would seem to indicate that these conditions have been brought about, at least in some instances, from the oxidation of iron contained in the clay and in others from the accumulation of layers of limonite around the exterior of clay fragments after these were torn from the parent mass. Even where the shales or concretions are in place in the clays, as at Glen Cove and Gay Head, the clays themselves must be regarded as merely part of the moraine, representing portions of the Cretaceous beds which were eroded and transported bodily or else shoved forward or squeezed upward from their original positions by the advancing ice front and not as undisturbed strata in place.

This conspicuous feature, therefore, consisting of hardened fragments and concretions, while it must be recognized as more or less characteristic where it occurs so conspicuously, may not always be an original phase of the deposit, but may in certain exposures be due merely to the accident of their location within the area of glacial disturbance.

Examples of erosion, transportation, and deformation of the Cretaceous deposits by ice action are conspicuous throughout almost the entire morainal area from Marthas Vineyard to Staten Island. In only two limited localities are the phenomena wanting. One of these is the northern or Orient Point branch of the moraine on Long Island; the other is where the moraine rests upon the serpentine hills of Staten Island. In the last-named locality the absence of Cretaceous material is due to the fact that the Cretaceous deposits did not extend north of these hills, while at Orient Point its absence is probably to be explained on the theory that this point represents a second or more recent morainal deposit, and that all of the Cretaceous material had been previously eroded and included in the older or Montauk Point branch.

On the several islands the exact conditions under which the fossil plants occur vary to some extent, and variations in conditions may be noted between certain localities on the same island. Within our region the farthest north that any Cretaceous material has been positively identified is on Naushon, the most eastern of the Elizabeth Islands, where there is a limited amount of plastic clay and some of the characteristic ferruginous concretions containing lignite, all included in the moraine. The farthest east that any similar material has been reported is Chappaquiddick, at the southeastern extremity of Marthas Vineyard, where characteristic species of Cretaceous plants occur in the ferruginous shaly fragments which form a large part of the reassorted drift material of that locality. Thus far no positive evidence has been obtained of the presence of a Cretaceous flora farther to the north, on Cape Cod, or farther to the east, on Nantucket, and definite proof that any of the Cretaceous formations were represented in those localities at all has not been recorded, so far as I am aware.

At Nashaquitsa, on Marthas Vineyard, the plant remains occur in clay nodules, embedded in the variegated clays of the cliff, which apparently form the outcropping edge of a basin or trough of which the Gay Head section is part of the opposite rim.

This clay deposit is somewhat different in coloring and texture from that of any other locality, and for that reason I have thought it possible that it might represent a distinct geologic horizon. It is, however, more or less involved with the overlying moraine and the adjacent sandy clays of the Weyquosque series, so that its exact stratigraphic position is uncertain, and, unfortunately, the plants collected are few in number and are largely of uncertain identity. Of the 222 species described in this monograph only 13 are listed from this locality, and of these four are only provisionally identified and two others are described as new.

At Gay Head fossil plants occur in certain of the gray sandy clays and in the ferruginous nodules and concretions, either in place or scattered in the talus accumulations of the escarpment. The stratigraphic relations of the various beds represented in this section are too uncertain for definite conclusions on account of the tilting and distortion to which they have been subjected; but inasmuch as 103 species of fossil plants—a large majority of them representing well-known Cretaceous types—have been identified from this locality alone, the age of the beds from which they came can not be questioned. Both the Raritan and the Cliffwood formations are represented in these species.

On Block Island, at all the localities, the fossils were found only as morainal material, in ferruginous shale or sandstone, but mostly in close association with transported or eroded masses of plastic and lignitic clay. No organic remains of any kind, other than the lignite, have been found in these clays; but their lithologic characters and the close association with them of the characteristic ferruginous material containing Cretaceous leaves are strong presumptive evidence of their age, especially as they lie directly on the line of strike between the clays of Marthas Vineyard on the east and those of Long Island on the west.

On Long Island the localities where Cretaceous fossil plants have been found are scattered throughout the hills from Montauk Point to Brooklyn. At most of these localities the plants occur in the moraine, and careful investigation would undoubtedly result in making known a number of others, so as to include practically the entire morainal area.

On Little Neck, in Northport Harbor, and at Cold Spring, impressions of leaves occur in the clays, while at Glen Cove numerous specimens have been found in a layer of ferruginous shale, interbedded with the clays. This shale is more or less fractured and slickensided, apparently representing a fault line or shear plane in the clay, along which atmospheric waters percolated, oxidizing the iron in the clay and transforming it into a thin layer of ferruginous shale along the line of fracture. At this locality the clays are not only disturbed as a whole and more or less tilted, but they are also locally disturbed by landslips, the effects of which may be seen in the changes which take place from year to year on the face and at the base of the bluff. Next to the Gay Head exposure this is the locality which has yielded the greatest number of fossil plants. They occur in the layer of shale above mentioned, and also in the fragments which have been eroded from the exposure and scattered along the beach.

At Sea Cliff, near Mott Point on Manhassett Neck, and at Elm Point on Great Neck, clays are exposed, but no fossil leaves have been found in them. At the locality first mentioned the matrix in which the leaf impressions occur is exactly

similar to the Glen Cove shale, but its outcrop has not been located. The material is abundantly represented in the morainal deposits of the vicinity, and practically the same conditions prevail at the other two localities. In no instance can even the clay exposures be definitely identified as outcrops, but they apparently are isolated masses which have been torn from the underlying beds and deposited as great clay bowlders in the moraine. The differences between these large masses and smaller ones, and between the fragments that are partly and those that are wholly oxidized, are differences in degree only, and all are clearly the result of glacial erosion and transportation.

On Staten Island the clays at Kreischerville and Green Ridge contain quantities of lignite and numerous leaf beds. At the latter locality they are in place and only the surface of the exposure has suffered any disturbance. At Kreischerville the beds appear to have been redeposited to a considerable extent, as the plant remains often occur in lenses or pockets and the accompanying sandy layers are conspicuously cross-bedded. Amber and charred wood, in considerable abundance, are mixed with the vegetable débris at this locality, as recently described by me in a paper on "The Occurrence and Origin of Amber in the Eastern United States."[a]

At all the other Staten Island localities small masses of what are apparently Cretaceous clays and sands occur in the moraine, but at these localities the fossil leaf impressions have been found only in the accompanying ferruginous shales and concretions.

The former presence of not only the Cliffwood but also higher formations, throughout the insular area, is also proved by the occurrence of Cretaceous invertebrate fossils in the moraine on Staten Island, Long Island, and Block Island,[b] in addition to the well-known occurrence of similar fossils, together with vertebrate remains, in place, in the Gay Head section on Marthas Vineyard, and scattered morainal material at Indian Hill and Chappaquiddick.[c] None of these fossils, however, has been found anywhere in any of the plant-bearing beds, so far as I am aware, and they have therefore proved of no value as correlation factors in connection with these deposits. The point of greatest interest in connection with them is probably the fact of their occurrence at Arrochar, on Staten Island, and at Brooklyn, on Long Island, indicating a former overlap of upper Cretaceous strata in that vicinity, which must have extended throughout the area now occupied by New York Harbor, the East River, and probably a part of the Hudson River Valley, but was later entirely eroded.

CORRELATION OF THE INSULAR AND ALLIED FORMATIONS.

The stratigraphic position of the formations discussed in connection with this monograph may be understood by reference to the following table, in which are set forth the views of a number of recent authorities:

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a Am. Naturalist, vol. 39, 1905, pp. 137–145.

b Hollick, A., Trans. New York Acad. Sci., vol 11, 1892, p. 98; ibid., vol. 15, 1895, pp. 3–5; ibid., vol. 16, 1896, pp. 11 and 16.

c Lyell, Travels in North America, vol. 1, 1845, pp. 203–206; Stimpson, Am. Jour. Sci., vol. 29, 1860, p. 145; Shaler, Bull. Mus. Comp. Zool. Harvard, vol. 16, 1889, pp. 89–97; Hollick, Trans. New York Acad. Sci., vol. 13, 1893, p. 16; Bull. New York Bot. Gard., vol. 2, 1902, pp. 400–401; Woodworth, Bull. Geol. Soc. Am., vol. 11, 1900, pp. 459–460; Brown, Am. Jour. Sci., vol. 20, 1905, pp. 229–238.

Table of correlations of the insular and allied formations.

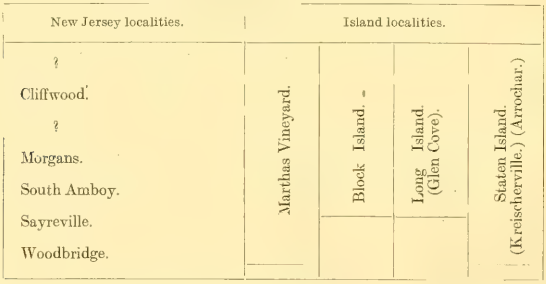
White, C. A., Bull. U. S. Geol. Survey No. 82, 1891, p. 79.		Ward, Lester F., Fifteenth Ann. Rept. U. S. Geol. Survey, 1893–94, pp. 307–397.			Clark, W. B., Bull. Geol. Soc. Am., vol. 6, 1894, p. 480.	Clark, W. B., and others, Ann. Rept. State Geologist N. J., 1897, p. 174; Bull. Geol. Soc. Am., vol. 13, 1902, pp. 212, 213.		Clark, W. B., Am. Jour. Sci., vol. 18, 1904, p. 440.			Weller, Stuart, Ann. Rept. State Geologist N. J., 1904, pp. 143, 147.		Cretaceous plant-bearing horizons on the islands of southern New York and New England.	
													New Jersey formations.	European equivalents.
Marine.	Upper marl (in part).				Manasquan.	Upper Cretaceous.	Manasquan.	Upper Cretaceous.	Danian.[a]	Manasquan.	D	Manasquan.		
	Middle marl.				Rancocas.		Rancocas.			Rancocas.	C	Long Branch. Vincenttown. Sewell.		
	Lower marl.				Red Bank. Navesink.		Monmouth.		Senonian.[a]	Monmouth.	B	Tinton. Red Bank. Navesink. Mount Laurel.		
	Clay marl.				Matawan.		Matawan.			Matawan.	A	Wenonah. Marshalltown. Columbus. Woodbury. Merchantville.	Matawan?	Senonian to Cenomanian (not differentiated).
Nonmarine.	Plastic clays.	Newer Potomac.	Upper.	Albirupean {Upper (=Island series and Raritan.) Lower.} Iron ore.	Raritan.	Lower Cretaceous.	Raritan.		Cenomanian.[a]	Magothy and Cliffwood.		Cliffwood (as a member of Raritan).	Cliffwood.	
								Lower Cretaceous.	Albian.[a]	Raritan.			Raritan (not differentiated).	
	Potomac.	Older Potomac.	Middle.	Aquia Creek.			Patapsco.		Neocomian.[a]	Patapsco.				
			Basal.	Mount Vernon. Rappahannock. James River.		Upper Jurassic?	Arundel. Patuxent.	Jurassic?		Arundel. Patuxent.				

[a] European equivalents.

From an analysis of the above table it may be seen that so far as the insular plant-bearing formations are concerned they occupy a position which is included in the plastic clays and clay marls of White, the Raritan and Cliffwood formations of Clark, and the Newer (upper) Potomac of Ward. A slight difference of opinion may be noted in regard to the exact geologic age to which these formations are referred, but there is a general agreement in regarding the Raritan and Cliffwood beds, respectively, as the summit of the Lower Cretaceous and the base of the Upper Cretaceous, and this accords with the paleobotanical evidence, as indicated in the last column of the table, and as will be more fully set forth in the botanical discussion. It may also be pertinent to remark in this connection that this evidence has not hitherto been adequately presented, and that possibly some slight modification of the views of the authors quoted might have resulted if all the facts now in our possession had been known to them.

In New Jersey successively higher horizons in the Raritan formation are represented by the plant-bearing deposits at Woodbridge, Sayreville, South Amboy, and Morgans, all of which places are on or near the coast. The Cliffwood formation, with possibly a part of the Matawan, is exposed in the bluff at Cliffwood. The plant-bearing deposits on the islands, whose flora is described in this work, have varying limits at different localities, including the Cliffwood formation and possibly higher horizons with varying amounts of the Raritan. The apparent relationships of the beds at the different localities are approximately shown in the following diagram:

Approximate relationships of beds at the different localities.



The "?" between Cliffwood and Morgans indicates a possibly intermediate bed whose flora has not yet been critically studied, and the upper "?" indicates that some of the plant-bearing beds in the bluff at Cliffwood may lie above the formation of that name.

DESCRIPTIONS OF SPECIES.

PTERIDOPHYTA.

Order FILICALES.

Family GLEICHENIACEÆ.

GLEICHENIA GRACILIS Heer?

Pl. I, fig. 9.

Gleichenia gracilis Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 52, pl. 10, figs. 1–5, 6a–11; pl. 26, figs. 13b, 13c, 13d; "*Gleichenia gracilis* Heer (?)," Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 57, pl. 3, fig. 3.

This specimen is too imperfect for satisfactory comparison with any descriptions or figures, and it is too fragmentary to serve as the basis for a description of a new species. It is possible that it may represent a larger, lower portion of a frond of *Gleichenia gracilis* than is depicted in any of Heer's figures of that species (loc. cit.), and it may also be compared with *G. acutiloba* Heer[a], from which species also it seems to differ mostly in the smaller size of its pinnules.

Locality: Black Rock Point, Block Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

GLEICHENIA PROTOGÆA Debey and Ettingshausen?

Pl. I, fig. 8.

Gleichenia protogæa Deb. and Etts., Denkschr. Wien Akad. Wissensch., Math.-Naturwiss Cl., vol. 17 (Urwelt. Acrobryen Kreidegebirg. Aachen und Maestricht), 1859, p. 191, pl. 1, figs. 11, 12, g, h.

This fragment, although too small for satisfactory identification or comparison, is certainly referable either to this or to one of the closely allied species of *Gleichenia* from the Cretaceous of Greenland, Switzerland, and Europe.[b]

Locality: Gay Head, Marthas Vineyard. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Family CYATHEACEÆ.

THYRSOPTERIS GREVILLIOIDES (Heer) n. comb.

Pl. I, figs. 10–13.

Sphenopteris grevillioides Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 34, pl. 11, figs. 10, 11; White, Am. Jour. Sci., vol. 39, 1890, p. 97, pl. 2, fig. 1; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.
Grevillea tenera Velenovsky, Fl. Böhm. Kreideform., pt. 4, 1885, p. 11 [72], pl. 7 [30], figs. 9, 14, 16.

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[a] Neue Denksch. Schw. Gesellsch., vol. 24 (Fl. Quedlinburg), 1872, p. 5, pl. 1, figs. 2, 2b; Fl. Foss. Arct., vol. 3 (Kreide-Fl.), p. 97, pl. 26, figs. 14, 14b.

[b] *G. comptoniæfolia* (Deb. and Etts.) Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 49, pl. 11, figs. 1, 2 (=*Didymosorus comptoniifolius* Deb. and Etts., Denkschr. Wien Akad., etc., vol. 17, 1859, p. 186, pl. 1, figs. 1–5).
G. delicatula Heer, ibid., p. 54, pl. 9, figs. 11e, 11f; pl. 10, figs. 16, 17.
G. Nauckhoffi Heer, ibid., p. 90, pl. 25, fig. 4.

These remains are undoubtedly identical with those described by Heer from the Cretaceous of Greenland and by Velenovsky from the Cretaceous of Bohemia. That they belong with the ferns can hardly be questioned, and I have referred them with but little hesitation to the more modern genus *Thyrsopteris* rather than to the Paleozoic genus *Sphenopteris*, which latter is, in part at least, now included in the order Cycadofilicales.

The possibility of relationship between these fragments of sterile fronds and the fertile fronds next described under the name *Onoclea inquirenda* (Hollick) might perhaps be suggested, but so far as the facts now in our possession are concerned any discussion of such possible relationship would be of but little value. It may, however, be pertinent to recall that several species of fertile fronds, similar in appearance to those of *Onoclea*, have been included by Heer in the genus *Thyrsopteris*, references to which may be found under the discussion of *Onoclea inquirenda* in this monograph.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Family POLYPODIACEÆ.

ONOCLEA INQUIRENDA (Hollick) n. comb.

Pl. I, figs. 1–7.

Caulinites inquirendus Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 406, pl. 70, fig. 3.

"Fruit, composed of round carpels or spores," Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 63, pl. 180, fig. 11.

Remains consisting of a simple straight stem (rachis?), with pinnately arranged branchlets (pinnæ?) about 1–2 centimeters in length, bearing on each side a single row of spheroidal capsules (sori?) 1–1.5 millimeters in diameter.

The above amended description is given for the reason that the original description was inadequate, having been based upon very fragmentary and incomplete material. The figure which accompanied this description is reproduced on Pl. I, fig. 5. It apparently represents dismembered parts of an immature specimen. It was included by me in the monocotyledonous genus *Caulinites* on account of its similarity in appearance to the figures of *C. fecundus* Lesq.,[a] although its probable relationship with the ferns was recognized, and the reference of *C. fecundus* to the genus *Onoclea*, by Knowlton,[b] was mentioned.

With the aid of the additional material now in our possession we are enabled to form a better idea of the general appearance of the organism and may consider it and other similar remains as apparently representing the fertile fronds of ferns, and the question of botanical relationship is thus reduced to that of the fern genus which they most nearly resemble.

Some of the smaller detached portions of our specimens resemble *Osmunda petiolata* Heer[c] and *O. Öbergiana* Heer,[d] from the Cretaceous of Greenland, and com-

[a] Tertiary Flora, pl. 14, figs. 1–3.
[b] Bull. U. S. Geol. Survey No. 152, p. 153.
[c] Fl. Foss. Arct., vol. 3 (Kreide-Fl.), p. 57, pl. 3, figs. 2c, 2d.
[d] Ibid., p. 98, pl. 26, fig. 9d.

parisons may also be made with *Thyrsopteris Murrayana* (Brongt.) Heer,[a] *T. Maakiana* Heer,[b] *T. gracilis* Heer[c] and *Dicksonia clavipes* Heer,[d] from the Jurassic of Siberia.

Comparisons with living species of the above genera, and with others having similar characters, indicate that our fossils most nearly resemble *Onoclea*, and this resemblance would seem to justify their reference to the genus, even though we have thus far failed to find any associated sterile fronds which could properly be included in it.

Locality: Glen Cove, Long Island, Pl. I, figs. 1–4. Figs. 1–3 collected by David White. Specimens in U. S. Nat. Mus. Fig. 4 collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Little Neck, Northport Harbor, Long Island, Pl. I, fig. 5. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. I, fig. 6. Collected by David White. Specimen in U. S. Nat. Mus.

Nashaquitsa, Marthas Vineyard, Pl. I, fig. 7. Collected by David White. Specimen in U. S. Nat. Mus.

Order SALVINIALES.

Family MARSILEACEÆ.

MARSILEA ANDERSONI Hollick.

Pl. I, figs. 14–18.

Marsilea Andersoni Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 409, pl. 71, figs. 1–3.

The figures of the specimens upon which the original description of this species was based are reproduced on Pl. I, figs. 14–16, and figures of leaves of the living Mexican species, *M. Höltingiana* Schaff., introduced for comparison, are shown in figs. 19–21. It may be objected that the fossil specimens appear to be simple peltate rather than compound leaves, but it is probable that the pressure to which they were subjected in the process of fossilization resulted in the obliteration of the lines of demarcation between the leaflets, and this probability is strongly emphasized by the appearance of the flattened herbarium specimens, in which the borders of the overlapping leaflets are often difficult to distinguish from the nervation without the aid of a magnifying glass.

Figs. 17 and 18 represent poorly preserved specimens, which might not have received any attention except for the comparison made possible by the better preserved ones first discovered.

Fragmentary remains, apparently of similar appearance to ours, have been described and figured by several authors as ferns or gymnosperms, under various generic names, and one which perhaps merits critical consideration in this connection

[a] Fl. Foss. Arct., vol. 4 (Jura-Fl.), p. 30, pl. 1, figs. 4b, 4c; pl. 2, figs. 1, 4, 4b; pl. 8, fig. 11b.
[b] Ibid., p. 31, pl. 1, fig. 1b; pl. 2, figs. 5, 5b.
[c] Ibid., p. 32, pl. 1, fig. 5.
[d] Ibid., p. 33, pl. 2, figs. 7, 7b.

is *Cyclopteris tenue-striata* Heer[a] from the Cretaceous of Portugal, which may be more or less satisfactorily compared with our fig. 15. This species was subsequently referred by the same author to the genus *Ginkgo* and was included, with somewhat similar remains from the Cretaceous of Greenland, under the name *G. tenuestriata* Heer,[b] but their relationship is not very apparent, and while our species might be regarded as generically related to the former, it could hardly be so considered in connection with the latter. In any event the genus *Marsilea* would seem to be the one which possesses external leaf characters most nearly like those of the fossils.

Another organism to which attention may be called on account of its general superficial resemblance to those just mentioned is *Sphenoglossum quadrifolium* Emmons,[c] from the Triassic of North Carolina, a plant of uncertain botanical relationship which Fontaine subsequently suggested renaming *Actinopteris quadrifoliata*,[d] regarding it as probably a fern and comparing it with *A. peltata* (Göpp.) Schenk.[e] Ward also refers to this species under the heading "Plants of doubtful affinity" in his first paper on the "Status of the Mesozoic Floras of the United States,"[f] and the figure which accompanies his discussion is decidedly suggestive. It is unfortunate, however, that in no instance is the nervation any more clearly defined, either in the description or in the figure, than it is in ours.

Locality: Manhassett Neck, Long Island, Pl. I, figs. 14–16. Collected by A. E. Anderson, for whom the species is named. Specimens in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. I, figs. 17, 18. Collected by David White. Specimens in U. S. Nat. Mus.

Sagenopteris variabilis (Velenovsky) Venenovsky?

Pl. I, fig. 22.

Sagenopteris variabilis (Vel.) Vel., Abh. K. Böhm. Gesellsch. Wissensch., vol. 3 (Kvet. Cesk. Cenomanu), 1889, p. 40.

Thinnfeldia variabilis Vel., Gymnosp. Böhm. Kreideform., 1885, p. 6, pl. 2, figs. 1–5; pl. 3, fig. 12; Hollick, Bull. New York Bot. Gard., vol. 2, 1902, p. 403, pl. 41, fig. 12.

Not *T. variabilis* Fontaine, Mon. U. S. Geol. Survey, vol. 15 (Potomac or younger Mesozoic Fl.), 1889, p. 110, pl. 17, figs. 3–7; pl. 18, figs. 1–6.

It is possible that this specimen should be referred to *Marsilea Andersoni* Hollick, the species last described, but as the nervation characters of the latter are not well defined, I have thought it advisable, pending the possible discovery of better preserved specimens, to regard them merely as closely related.

Locality: Chappaquiddick, Marthas Vineyard. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] Cont. Fl. Foss. Portugal, 1881, p. 45, pl. 19, fig. 5.
[b] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 14, pl. 2, fig. 12a.
[c] Geol. Rept. Midland Counties North Carolina, 1856, p. 335, pl. 1, fig. 2.
[d] Mon. U. S. Geol. Survey, vol. 6 (Cont. Older Mesozoic Fl. Virginia), 1883, p. 121, pl. 52, fig. 3.
[e] Foss. Fl. Grenzsch. Keupers u. Lias Frankens, 1867, p. 23, pl. 6, figs. 3–5.
[f] Twentieth Ann. Rept. U. S. Geol. Survey, 1898-99, pt. 2, 1900, p. 310, pl. 47, fig. 2.

SPERMATOPHYTA.

Class GYMNOSPERMÆ.

Order CYCADALES.

Family CYCADACEÆ.

PODOZAMITES LANCEOLATUS (Lindley and Hutton) Schimper.

Pl. II, fig. 1.

Podozamites lanceolatus (Lind. and Hutt.) Schimp., Paleont. Veg., vol. 2, 1870, p. 160.
Zamia lanceolata Lindl. and Hutt., Foss. Fl. Great Britain, vol. 3, 1837, pl. 194.
Podozamites angustifolius (Eichwald) Schimper. Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 44, pl. 13, fig. 2; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 410, pl. 71, fig. 8.

This specimen, the only perfect cycad leaf thus far found within the area covered by this work, is apparently identical with the specimen from Woodbridge, N. J., described and figured by Newberry as *P. angustifolius* (loc. cit.), to which species I also formerly considered our specimen to belong. A more careful comparison, however, has led me to believe that these determinations were erroneous, especially after comparison with Velenovsky's figures of *P. lanceolatus* from the Cretaceous of Bohemia,[a] and Heer's from the Jurassic of Siberia.[b] This would imply a considerable vertical range for the species, but no greater than is known in some other persistent specific types, and in this connection it is of interest to record that in Alaska there has been found a fossil flora in which apparently Jurassic species of cycads are associated with undoubted Cretaceous angiosperms.[c]

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

PODOZAMITES sp.

Pl. VI, figs. 1–3.

Podozamites sp., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 62, pl. 180, fig. 4; Bull. New York Bot. Gard. vol. 2, 1902, p. 401, pl. 41, figs. 8, 9.

These, and a few other similar fragmentary remains, which probably represent leaves of cycads, are not very abundant in our collections, although several species have been recorded from the clays and clay marls of New Jersey, by Newberry[d] and by Berry,[e] to some one or another of which ours might be referred.

Locality: Chappaquiddick, Marthas Vineyard, Pl. VI, figs. 1, 3. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. VI, fig. 2. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] Gymnosp. Böhm. Kreideform., pl. 2, figs. 11–19, 24 in part.

[b] Fl. Foss. Arct., vol. 5 (Nachtr. Jura-Fl. Irkutsk), 1878, pl. 5, figs. 1–10.

[c] Manuscript rept. by Dr. F. H. Knowlton, U. S. Geol. Survey, on specimens collected by A. J. Collier in 1902. This association of floras was subsequently verified by means of specimens personally collected in 1903 at Collier's locality on Yukon River.

[d] *Podozamites angustifolius* (Eichw.) Schimp., *P. acuminatus* Hollick, and *P. marginatus* Heer. Mon. U. S. Geol. Survey, vol. 26, 1895 (1896) (Fl. Amboy Clays), pp. 44, 45, pl. 13, figs. 1–7.

[e] *Podozamites marginatus* Heer. Bull. New York Bot. Gard., vol. 3, 1903, p. 99, pl. 46, figs. 1–3.

Order CONIFERALES.

Family GINGKOACEÆ.

Czekanowskia dichotoma (Heer) Heer?

Pl. V, fig. 7.

Czekanowskia dichotoma Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 14, pl. 2, figs. 12b, 12c; pl. 3, fig. 1.
Sclerophyllina dichotoma Heer, ibid., vol. 1, 1868, p. 82, pl. 44, fig. 3; vol. 3 (Kreide-Fl.), 1874, p. 59, pl. 17, figs. 10, 11, 11b; pl. 20, fig. 6d; Hollick, Bull. New York Bot. Gard., vol. 2, 1902, p. 404, pl. 41, fig. 10.

This specimen is too fragmentary for other than a provisional identification, but it resembles some of the dismembered specimens depicted by Heer, especially those in his figs. 10 and 11, pl. 17 (loc. cit.).

Locality: Chappaquiddick, Marthas Vineyard. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Baiera grandis Heer?

Pl. II, figs. 44–46.

Baiera grandis Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 37, pl. 3, fig. 4.

The specimens from which these figures were drawn were selected from among a number of others, all of them either fragmentary or else ill defined. Fig. 44 represents a distorted specimen, in which part of the margin is bent underneath. It is therefore of little value for comparison; but figs. 45 and 46 agree quite well with Heer's figure above quoted. Whatever genus or species may be represented by these remains it was evidently a more or less common element in the Cretaceous flora of this region.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Protophyllocladus subintegrifolius (Lesquereux) Berry.

Pl. V, figs. 1–6.

Protophyllocladus subintegrifolius (Lesq.) Berry, Bull. Torrey Bot. Club, vol. 30, 1903, p. 440; ibid., vol. 31, 1904, p. 69, pl. 1, fig. 5.
Phyllocladus subintegrifolius Lesq., Am. Jour. Sci., vol. 46, 1868, p. 92.
Thinnfeldia Lesquereuxiana Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 37, pl. 44, figs. 9, 10; pl. 46, figs. 1–12b; Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 98, pl. 3, fig. 6; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Annals New York Acad. Sci., vol. 11, 1898, p. 58, pl. 3, figs. 4, 5; ibid., p. 419, pl. 36, fig. 6; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 59, pl. 11, figs. 1–17.
Thinnfeldia subintegrifolia (Lesq.) Knowlton, Bull. U. S. Geol. Survey No. 152, 1898, p. 228; Hollick, Bull. New York Bot. Gard., vol. 2, 1902, p. 403, pl. 41, figs. 13, 14.

This species was evidently an important element in the Cretaceous flora of North America. It is represented in the collections of Heer from Greenland and of Lesquereux and others from the western United States. It has been found in

the clay marls of New Jersey; it is one of the most abundant species in clays of that State, and a number of specimens have been collected on Staten Island, Block Island, and Marthas Vineyard.

Locality: Black Rock Point, Block Island, Pl. V, figs. 1, 2. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Chappaquiddick, Marthas Vineyard, Pl. V, figs. 3, 4. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Tottenville, Staten Island, Pl. V, fig. 5. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Princess Bay, Staten Island, Pl. V, fig. 6. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Family PINACEÆ.

Dammara borealis Heer.

Pl. II, figs. 2–11 in part, 12–26 in part, 27a.

Dammara borealis Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 54, pl. 37, fig. 5; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 31, pl. 1, fig. 17; Bull. New York Bot. Gard., vol. 2, 1902, p. 402, pl. 41, fig. 6; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r49; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 46, pl. 10, fig. 8.

"Seed vessels of coniferous plants," Hitchcock, Final Rept. Geol. Massachusetts, 1841, p. 430, pl. 19, figs. 4, 5.

Dammara microlepis Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 55, pl. 40, fig. 5; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 410, pl. 71, figs. 9, 10.

Eucalyptus Geinitzi Heer, Fl. Foss. Arct., vol. 6, (abth. 2), 1882, p. 93, pl. 45, figs. 4–9; pl. 46, fig. 12d; White, Am. Jour. Sci., vol. 39, 1890, p. 98, pl. 2, figs. 9, 10.

Dammara Cliffwoodensis Hollick [†], Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 61, pl. 48, figs. 8–11; Bull. Torrey Bot. Club, vol. 31, 1904, p. 69, pl. 1, fig. 11.

These scale-like organisms, which are among the most abundant and characteristic remains found in the Cretaceous deposits of America and Europe, are referred to the genus *Dammara* for the sake of convenience rather than from a conviction that this represents their true generic relationship, and this uncertainty has, if anything, been increased rather than diminished by the large amount of material which has recently been brought to light, but there seems to be but little question that all the specimens are coniferous, including those which Heer regarded as the fruit of *Eucalyptus Geinitzi* (loc. cit.). Heer recognized three species of *Dammara* from Greenland (*D. macrosperma, D. borealis,* and *D. microlepis*), but I have found it impossible to draw any line of specific distinction in the series of similar specimens represented by our figures. Intermediate forms between the larger ones, shown in figs. 2–6, which are apparently identical with *D. borealis* (loc. cit.) and the smaller ones shown in figs. 23–27a, which I can not distinguish from *D. microlepis* (loc. cit.), might be equally well referred to either species, as may be seen by comparing these with figs. 7–22, and hence I have included all under one specific name.

The first discovery of these organisms was apparently made on Marthas Vineyard and is to be credited to Edward Hitchcock, by whom they were described and figured, but not named. These figures are reproduced on Pl. II, figs. 12, 21, from his

Final Report of the Geology of Massachusetts, vol. 2, 1841, pl. 19, figs. 4, 5, and it is interesting to recall that he recognized their probable coniferous relationships in the following words (loc. cit., p. 430):

> Figs. 4 and 5 represent different individuals of another variety of vegetable remains. * * * These are not mere impressions; but a scale of carbonaceous matter, mixed with amber, marks the spot where the vegetable was imprisoned. The amber occupies longitudinal ridges, which in the plate are represented by white stripes. It seems to me very obvious that these remains must be the seed vessels of coniferous plants. The amber shows that they abounded in resin. * * *

David White was the next to describe and figure specimens from the same locality, in the American Journal of Science, vol. 39, 1890, p. 98, pl. 2, figs. 9, 10, which he referred to *Eucalyptus Geinitzi* Heer, remarking that the longitudinal furrows filled with resin "doubtless are the remains of gum or oil vessels, such as exist in the nuts of recent Eucalypts." His figures are reproduced on Pl. II, figs. 6, 15. A number of similar specimens were previously described and figured by Velenovsky, from the Cretaceous of Bohemia, as the fruit of *Eucalyptus Geinitzi*,[a] all more or less closely associated with leaves of that species, although subsequently the same author referred what are apparently specimens of the same to *Dammara borealis* Heer.[a] Heer was himself also apparently in doubt on the subject of their generic relationship, inasmuch as he says, in regard to *Dammara microlepis* (loc. cit., p. 55), that it "has a resemblance to the flower buds of *Eucalyptus Geinitzi*."

Newberry, in discussing the probable botanical relationship of specimens from the Cretaceous of New Jersey, on pp. 46, 47 of the Flora of the Amboy Clays (loc. cit.), says:

> In his Flora Fossilis Arctica (loc. cit.) Professor Heer describes and figures the scales of a cone of a conifer which very much resemble those of *Dammara australis*, and yet there are some reasons for doubting the accuracy of his reference. It may also be said that the fruit scales which he calls *Eucalyptus Geinitzi* * * * are without doubt generically the same. * * * The considerations which have led me to doubt whether these cone scales are those of *Dammara* are that we have found no *Dammara*-like leaves associated with them, whereas in one locality in New Jersey they occur in great numbers mingled with and apparently attached to the branchlets of an extremely delicate conifer much like Heer's *Juniperus macilenta*. * * * Another reason for doubting whether these are the scales of a species of *Dammara* is that in some of them traces of two seeds are apparently visible, while in *Dammara* there is but one seed under each scale.

The association of cone scales and branchlets above mentioned was not figured, but specimens were recently found in a collection from Woodbridge, N. J., with labels in Doctor Newberry's handwriting, in which the association is well shown, and the probable identity of the branchlets with a species of *Juniperus*, probably *J. hypnoides* Heer, is strongly indicated,[c] although any former actual living connection between them can not be determined.

Another instance of close association of similar scales with angiospermous leaves is described and figured by F. Krasser, under *Eucalyptus Geinitzi*, from the Cretaceous of Moravia,[d] but the proof of any actual connection between them is apparently no more satisfactory than in the other instance noted, or than is indicated on our Pl. II, fig. 11, where a scale of *Dammara* is shown superimposed on a fragment of *Poacites*.

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[a] Fl. Böhm. Kreideform., pt. 4, 1885, p. 1 (62), pl. 1 (24), figs. 1, 2; pl. 2 (25), figs. 6–11; pl. 4 (27), fig. 13 in part.
[b] Abh. K. Böhm. Gesellsch. Wiss., vol. 3 (Kvet. Cesk. Cenomanu), 1889, p. 7, pl. 1, figs. 28, 29.
[c] See Pl. II, figs. 26 in part, 27b, 28.
[d] Beitr. Pal. Oestr.-Ung., vol. 10, pt. 3 (Kreidefl. Kunstadt), 1896, p. 134 (22), pl. 16 (6), figs. 3, 6.

In view, therefore, of these conflicting facts and opinions, I have thought it advisable, until more definite evidence may be available, to include all of these scale-like organisms under one generic name and to regard them, at least tentatively, as belonging with the Coniferales. In this connection I have introduced, for comparison, the type figures of *Dammara* (?) *cliffwoodensis* Hollick,[a] which, together with the specimens recognized under *D. borealis* Heer and the two species next described, give a complete representation of these organisms thus far found in our vicinity. The specimens identified as *D. cliffwoodensis* by Berry[b] I am inclined to consider as more properly referable to the smaller forms of *D. borealis*.

Finally may be noted the scales described and figured by Knowlton from the Judith River beds of Montana, under the name *Dammara acicularis*,[c] which differ from most of our specimens merely in the possession of a relatively long awn at the apex. This feature, however, is not altogether wanting in some of ours, as may be seen in Pl. II, fig. 27a, and it is possible that it may have been present in the others but was not preserved, and as a matter of fact it is not indicated in Knowlton's fig. 3, which, if taken by itself, would unquestionably be regarded as a small specimen of *D. borealis*.

Locality: Gay Head, Marthas Vineyard, Pl. II, figs. 2–11 in part, 12, 15–22 (figs. 2–11 in part, 15–20, 22 collected by David White, specimens in U. S. Nat. Mus.; figs. 12, 21 collected by Edward Hitchcock).

Chappaquiddick, Marthas Vineyard, Pl. II, fig. 13. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Tottenville, Staten Island, Pl. II, fig. 14. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Glen Cove, Long Island, Pl. II, figs. 23, 24. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Woodbridge, N. J., Pl. II, figs. 25, 26 in part, 27a. Specimens in Mus. New York Bot. Gard.

Dammara northportensis Hollick.

Pl. II, figs. 33, 34.

Dammara Northportensis Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 405, pl. 70, figs. 1, 2.

This species, at the time it was originally described, was thought to be peculiar to the clays at Northport, Long Island, where it was first found, but recently specimens have been identified from the Cretaceous clays of New Jersey, and what may be the same species from those of Kreischerville, Staten Island, where it is quite abundant. These latter discoveries, however, were made too late for detailed investigation and inclusion in this work. The only other coniferous remains found associated with them at Northport are leafy branches of *Brachyphyllum macrocarpum* Newb., but at the other localities mentioned a number of other coniferous genera also occur.

Locality: Little Neck, Northport Harbor, Long Island. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

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[a] Trans. New York Acad. Sci., vol. 16, 1897, p. 128, pl. 11, figs. 5–8 (see Pl. II, figs. 29–32).
[b] Bull. New York Bot. Gard., vol. 3, 1903, p. 61, pl. 48, figs. 8–11.
[c] Bull. U. S. Geol. Survey No. 257, 1905, p. 134, pl. 15, figs. 2–5.

Dammara minor n. sp.

Pl. II, figs. 35–37.

Dammara microlepis Heer? Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 57, pl. 3, figs. 9a, 9b.

Scales top-shaped to rounded kite-shaped, about 5–8 millimeters wide above by 4–5 millimeters long; resin ducts relatively large.

At the time the first of these specimens were found, on Block Island, they were provisionally referred to *Dammara microlepis* Heer, with the following note (loc. cit., p. 57):

> The specimens figured on our plate are undoubtedly referable to the organisms which have been called *Dammara* and *Eucalyptus*, from the Cretaceous of America and the Old World. The ones under consideration are, however, smaller than any which have been previously figured, and might perhaps be referred to a new species; but, in view of the limited amount of material and its fragmentary condition, I have thought it best to refer the specimens provisionally to Heer's species.

Since then further material has been discovered in the Cretaceous clays at Kreischerville, Staten Island, and I am now satisfied that the specimens should be given a distinct specific rank. They are much smaller than any previously described, with shorter limbs, and they contain a relatively greater amount of resin. They are quite plentiful in the amber bed at Kreischerville, recently described by me.[a]

Locality: Balls Point, Block Island, Pl. II, figs. 35, 36. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Kreischerville, Staten Island, Pl. II, fig. 37. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Pinus sp.

Pl. II, figs. 39, 47, 48.

"*Pinus*, sp.?" Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 31, pl. 1, figs. 13, 20, 22; Newberry Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 47, pl. 9, figs. 5, 6.

Cones, more or less fragmentary, detached scales, and leaves, almost certainly belonging to pine trees, are abundantly represented in the Cretaceous deposits of this vicinity, especially in the clays at Kreischerville, Staten Island, but in no instance have they been found sufficiently well preserved for satisfactory identification with any described species. The fascicles of leaves appear to be in threes and the cones to be of medium size.

Similar remains from the Cretaceous of New Jersey are described by Newberry (loc. cit.), and he also describes and figures the leaves as occurring in three-leaved fascicles, but says: "No cones have been found with them which could certainly be attributed to the genus *Pinus*, but some which are considerably macerated and decayed * * * may perhaps have been pine cones * * * ."

Locality: Gay Head, Marthas Vineyard, Pl. II, figs. 39, 48. Collected by David White. Specimens in U. S. Nat. Mus.

Kreischerville, Staten Island, Pl. II, fig. 47. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

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[a] Am. Naturalist, vol. 39, 1905, pp. 137–145, pls. 1–3.

Cunninghamites elegans (Corda) Endlicher.

Pl. III, fig. 1.

Cunninghamites elegans (Corda) Endl., Synop. Conif., 1847, p. 270; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 48, pl. 5, figs. 1–7; Hollick, Trans. New York Acad. Sci., vol. 16, 1897, p. 129, pl. 11, fig. 2; Bull. New York Bot. Gard., vol. 2, 1902, p. 402, pl. 41, fig. 11; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 64 (?); Bull. Torrey Bot. Club, vol. 31, 1904, p. 70, pl. 3, figs. 7–9, 11.

Cunninghamia elegans Corda, in Reuss, Verstein. Böhm. Kreideform. (abth. 2), 1846, p. 93, pl. 49, figs. 29–31.

The single specimen of this well-defined species here figured is the only one thus far found within the insular area, although it is not rare in both the Raritan and Cliffwood formations in New Jersey. It occurs in the upper Cretaceous of Europe, in the Patoot beds of Greenland, and has recently been identified from the Judith River beds of Montana,[a] but, so far as I am aware, has never been recorded from any typical Dakota group locality. We have generally regarded it as one of the characteristic eastern Cretaceous species which served to indicate the closer relationship with the Cretaceous of Greenland and Europe than with that of the western United States, but this view, in the light of the above-mentioned discovery, must now be somewhat modified.

Locality: Chappaquiddick, Marthas Vineyard. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Sequoia heterophylla Velenovsky.

Pl. III, figs. 2, 3.

Sequoia heterophylla Vel., Gymnosp. Böhm. Kreideform, 1885, p. 22, pl. 12, fig. 12; pl. 13, figs. 2–4, 6–9; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 30, pl. 1, fig. 21; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 49, pl. 6, figs. 1–13.

Fragmentary remains of this species occur in the clays at Kreischerville, Staten Island, but thus far they have not been found elsewhere within the area covered by this monograph, although the species is abundantly represented in the Amboy clays of New Jersey, and is reported from the Potomac of Virginia and the Judith River beds of Montana. It is a characteristic element in the Cretaceous of Europe, and it is somewhat remarkable that it has not been recorded from any of the Greenland horizons.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Fig. 2, specimen in Mus. New York Bot. Gard.; fig. 3, specimen in Mus. Staten Island Assn. Arts and Sci.

Sequoia ambigua Heer.

Pl. III, figs. 7, 8.

Sequoia ambigua Heer, Fl. Foss. Arct., vol. 3 (abth. 2), 1874, p. 78, pl. 21, figs. 1, 2a–9a, 10a, 10c, 11; White, Am. Jour. Sci., vol. 39, 1890, p. 97, pl. 2, figs. 2, 3; Uhler, Trans. Md. Acad. Sci., vol. 1, 1892 (1901), p. 207; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.

The recorded occurrence of this species within the insular area is thus far confined to the Gay Head locality, and it has not as yet been reported from any of the

[a] Knowlton, F. H., Fossil plants of the Judith River beds: Bull. U. S. Geol. Survey No. 257, 1905, p. 135, pl. 15, fig. 1.

New Jersey horizons. The relatively broad and blunt leaves serve to distinguish it, however, from the other species of *Sequoia* with which it is associated and leave but little doubt in regard to its identity with the Greenland (Kome) specimens figured by Heer (loc. cit.). Our specimens indeed appear to resemble the latter much more closely than do those referred to this species by Fontaine, from the lower Cretaceous of Virginia.[a] As it has not been identified in any deposits of the Old World Cretaceous, we may perhaps regard it as a Greenland–eastern North America species.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Sequoia Reichenbachi (Geinitz) Heer.

Pl. II, fig. 40; Pl. III, figs. 4, 5.

Sequoia Reichenbachi (Gein.) Heer, Fl. Foss. Arct., vol. 1, 1868, p. 83, pl. 43, figs. 1d., 2b, 5a, 5d, 5dd, 8, 8b; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 49, pl. 9, fig. 19; Hollick, Trans. New York Acad. Sci., vol. 16, 1897, p. 128, , pl. 12, figs. 3b, 5; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 59, pl. 48, figs. 15–17, 18?, 20; Bull. Torrey Bot. Club, vol. 31, 1904, p. 69, pl. 4, fig. 8.

Araucarites Reichenbachi Gein., Charakter. Schichten u. Petref. Sächs.-Böhm. Kreidegeb., vol. 3, 1842, p. 98, pl. 24, fig. 4.

Sequoia Couttsiæ Heer. Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 30, pl. 1, fig. 5.

The cone here included (see Pl. II, fig. 40) is somewhat larger than any specimen of the species which I have seen elsewhere depicted, and hence this reference may be questioned, but in regard to the leafy twigs there can hardly be any doubt that they belong to the species as generally recognized. The genus *Sequoia*, however, needs careful revision, and if this is ever done it is probable that the number of species will either be reduced or at least may undergo considerable rearrangement, as may be seen merely by comparing certain figures of five Cretaceous species so described or referred by Heer and Lesquereux alone.[b] If such a revision should result in restricting or modifying the great horizontal and vertical range now necessarily implied in the recognition of the validity of some of these species, it would obviate some of the suspicions which I believe nearly all paleobotanists have entertained in this connection. *S. Reichenbachi* alone, as we now recognize it, has a geographical distribution which includes the United States, Canada, Greenland, and Europe, and a range in time which apparently includes the upper part of the Jurassic and the whole of the Cretaceous period.

Locality: Gay Head, Marthas Vineyard, Pl. II, fig. 40. Collected by David White. Specimen in U. S. Nat. Mus.

Kreischerville, Staten Island, Pl. III, figs. 4, 5. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

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[a] Mon. U. S. Geol. Survey, vol. 15 (Potomac Fl.), p. 245, pl. 118, fig. 2; pl. 120, figs. 1–6; pl. 127, fig. 5; pl. 132, fig. 3.

[b] *S. Reichenbachi* (Gein.) Heer, loc. cit. and ibid., vol. 3 (Kreide-Fl.), pl. 12, fig. 7d; pl. 20, fig. 7a; pl. 22, fig. 5f; pl. 36, figs. 1–8.

S. sublata Heer, ibid., pl. 34, fig. 1a; ibid., vol. 6 (abth. 2), pl. 17, fig. 1.

S. fastigiata (Sternb.) Heer, ibid., vol. 3 (Kreide-Fl.), pl. 27, figs. 5, 6; pl. 38, fig. 13.

S. concinna Heer, ibid., vol. 7, pl. 51, fig. 9; pl. 53, fig. 1b.

S. condita Lesq., Eighth Ann. Rept. U. S. Geol. and Geog. Survey Terr., 1874 (1876), pl. 4, fig. 7.

Sequoia fastigiata (Sternberg) Heer?

Pl. III, fig. 15.

Sequoia fastigiata (Sternb.) Heer, Neue Denkschr. Schw. Gesellsch., vol. 23 (Fl. Moletein), 1869, p. 11, pl. 1, figs. 10–13.
Caulerpites fastigiatus Sternb., Verst., vol. 2, 1833, p. 23.

This specimen agrees better with some of the later of Heer's figures[a] than it does with his original reference (loc. cit.), but the group in which it may be included—with *S. gracilis* Heer and *S. concinna* Heer—requires careful revision and rearrangement. For this reason, and also because of the fragmentary character of our specimen and the fact that the species has heretofore been recorded from the United States only in the Dakota group of Kansas, I have thought it best to question the specific reference.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Sequoia gracilis Heer?

Pl. III, fig. 14

Sequoia gracilis Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 80, pl. 18, fig. 1c; pl. 22, figs. 1a–5e, 7–10.

This specimen is too imperfectly preserved for accurate comparison or positive identification, and it might almost equally well be referred to certain forms of *S. concinna* Heer,[b] from many of which it can hardly be distinguished.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Sequoia sp.

Pl. III, fig. 6.

Sequoia sp., Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 410, pl. 72, fig. 2.

This specimen is manifestly too fragmentary for satisfactory specific identification, and while it might be referred to some one or another of the species in the group to which *S. Reichenbachi* may be considered as belonging, such reference could be provisional only, and I have thought it as well to merely place it under its generic name.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Cone of Sequoia concinna Heer.

Pl. II, fig. 41.

Sequoia concinna Heer, Fl. Foss. Arct., vol. 7, 1883, p. 13, pl. 49, figs. 8b, 8c; pl. 50, fig. 1b; pl. 51, figs. 2–10; pl. 52, figs. 1–3; pl. 53, fig. 1b.
"*Eucalyptus Geinitzi*, flower?," White, Am. Jour. Sci., vol. 39, 1890, p. 98, pl. 2, fig. 11.

Our figure was drawn from the same specimen as that figured by White, above quoted, which he referred provisionally to the flower of *Eucalyptus Geinitzi* Heer, but in regard to which he remarks (loc. cit., p. 98): "It may belong to a conifer."

[a] Fl. Foss. Arct., vol. 6 (abth. 2), pl. 3, fig. 7; ibid., vol. 7, pl. 51, fig. 12; pl. 53, figs. 3, 4.
[b] Fl. Foss. Arct., vol. 7, pl. 52, figs. 2, 3.

That this latter suggestion is probably correct may be seen by comparing the figure with Heer's fig. 8c, pl. 49 (loc. cit.).

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Coné of Sequoia sp.

Pl. II, fig. 42.

This is apparently a water-worn inner portion of a *Sequoia* cone, such as is frequently found in accumulations of vegetable débris which have been subjected to attrition by water transportation.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Brachyphyllum macrocarpum Newberry.

Pl. III, figs. 9, 10.

Brachyphyllum macrocarpum Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 51 (footnote), pl. 7, figs. 1–7; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 406, pl. 70, figs. 4, 5; Berry, Bull. Torrey Bot. Club, vol. 32, 1905, p. 44, pl. 2, fig. 9.

Thuites crassus Lesq., Cret. and Tert. Fl., 1883 (1884), p. 32.

Brachyphyllum crassum Lesq., Proc. U. S. Nat. Mus., vol. 10, 1887, p. 34; Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 32, pl. 2, fig. 5; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 51, pl. 7, figs. 1–7. Not *B. crassum* Tennison-Woods, Proc. Linn. Soc. New South Wales, vol. 7, 1883, p. 660.

This well-defined species occurs in the clays at Northport, Long Island, Kreischerville, Staten Island, South Amboy, N. J., and in the clay marl at Cliffwood, N. J. It is hardly to be distinguished from *Echinostrobus squammosus* Vel.,[a] and may prove to be identical with it.

Locality: Little Neck, Northport Harbor, Long Island. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Widdringtonites Reichii (Ettinghausen) Heer.

Pl. IV, figs. 6–8.

Widdringtonites Reichii (Etts.) Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 51, pl. 28, fig. 5; Newberry, Mon U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 57, pl. 8, figs. 1–5.

Frenelites Reichii Etts., Kreidef. Niederschoena, 1867, p. 246, pl. 1, figs. 10a–10c; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 29, pl. 1, fig. 23; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.

This species, originally described from the Cretaceous of Saxony, is very abundant in the clays of New Jersey and at Kreischerville, Staten Island, and it is also represented in the collections made on Marthas Vineyard. It is one of the species which may be regarded as indicating the close equivalence of the Cretaceous of eastern North America with that of Greenland and Europe, rather than with that of the western United States, whence it has not as yet been recorded.

Locality: Kreischerville, Staten Island, Pl. IV, figs. 6, 7. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. IV, fig. 8. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] Gymnosp. Böhm. Kreideform., p. 16, pl. 6, figs. 3, 6–8.

Widdringtonites subtilis Heer.

Pl. IV, figs. 2–5.

Widdringtonites subtilis Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 101, pl. 28, figs. 1–1c; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 57, pl. 10, figs. 2–4.

Widdringtonites Reichii (Etts.) Heer? Hollick, Ann. New York Acad. Sci., vol. 11, 1898, p. 58, pl. 3, fig. 8.

This species, unlike *W. Reichii*, appears to be restricted in its geographical distribution to Greenland and the eastern United States, although certain of the coniferous remains from the Cretaceous of Bohemia, referred by Velenovsky to *Cyparissidium minimum* Vel.[a] and to *Juniperus macilenta* Heer,[b] present a striking superficial resemblance to it.

Locality: Gay Head, Marthas Vineyard, Pl. IV, figs. 2–4. Collected by David White. Specimens in U. S. Nat. Mus.

Black Rock Point, Block Island, Pl. IV, fig. 5. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Widdringtonites fasciculatus n. sp.

Pl. IV, fig. 1.

Branches and branchlets thick and inflated, the latter terminating in relatively short fascicles of delicate, minutely-leaved twigs.

This specimen has somewhat the appearance of a certain form of *W. subtilis* Heer,[c] in regard to which he says (loc. cit., p. 101):

In many specimens the twigs are more closely grouped. * * * They, and also the leaves, are strongly appressed, on account of which the plant presents a different appearance. I at first took it to be a *Trichomanes*, until a more exact investigation convinced me that it represented the closely fascicled twigs of *W. subtilis*, on which, with a magnifying glass, one could see the small appressed leaves.

Our specimen, however, appears to be so distinctive that it seems to be deserving of a new specific name, under which, if thought advisable, Heer's figure above referred to might be included.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Frenelopsis Hoheneggeri (Ettingshausen) Schenk?

Pl. IV, figs. 9, 10.

Frenelopsis Hoheneggeri (Etts.) Schenk, Palaeontog., vol. 19 (Heft. I), 1869, p. 13, pl. 4, figs. 5–7; pl. 5, figs. 1, 2; pl. 6, figs. 1–6; pl. 7, fig. 1; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 58, pl. 12, figs. 4, 5; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 410, pl. 72, fig. 1; Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 71, pl. 4, figs. 9, 10.

Thuites Hoheneggeri Etts., Abh. K.-K. Geol. Reichsanst., vol. 1 (abth. 3, no. 2), 1852, p. 26, pl. 1, figs. 6, 7.

These remains are so indefinite that I have merely referred them provisionally to this species, and in this I have been largely influenced by the fact that similar remains, found in the clays and clay marls of New Jersey, have been so referred by Newberry and Berry (loc. cit.)

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[a] Gymnosp. Böhm. Kreideform., p. 19, pl. 10, fig. 4.
[b] Ibid., p. 29, pl. 11, figs. 3, 4, 6; pl. 12, fig. 1.
[c] Fl. Foss. Arct., vol. 3 (Kreide-Fl.), pl. 28, fig. 1c.

Locality: Center Island, Oyster Bay, Long Island, Pl. IV, fig. 9. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. IV, fig. 10. Collected by David White. Specimen in U. S. Nat. Mus.

Moriconia cyclotoxon Debey and Ettingshausen.

Pl. III, figs. 16, 17.

Moriconia cyclotoxon Deb. and Etts., Denkschr. Wien Akad., vol. 17, 1859, p. 239, pl. 7, figs. 23–27; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 55, pl. 10, figs. 11–21; Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 57, pl. 3, fig. 10; ibid, p. 418, pl. 37, fig. 8; Berry, Bull. New York Bot. Gard. vol. 3, 1903, p. 65, pl. 43, fig. 4; pl. 48, figs. 1–4; Bull. Torrey Bot. Club, vol. 31, 1904, p. 70.

This well-marked species is not uncommon in the clays at Kreischerville and sparingly elsewhere on Staten Island and on Block Island. In New Jersey, both in the clays and in the clay marls, it is abundantly represented. In common with *Widdringtonites Reichii* (Etts.) Heer, it may be regarded as one of the conifers peculiar to the Cretaceous of eastern North America, Greenland, and Europe, as it has not yet been recorded from any locality in the western United States.

Locality: Princess Bay, Staten Island, Pl. III, fig. 16. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Black Rock Point, Block Island, Pl. III, fig. 17. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Cyparissidium gracile (Heer) Heer?.

Pl. III, fig. 11.

Cyparissidium gracile (Heer) Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 74, pl. 17, figs. 5b, 5c; pl. 19, figs. 1-10; pl. 20, figs. 1d, 1e; pl. 21, figs. 9b, 10d.
Widdringtonites gracilis Heer, ibid., vol. 1, 1868, p. 83, pl. 43, figs. 1e, 1ee, 1f, 1g, 3c.
"*Sequoia Reichenbachi* Gein?" Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 30, pl. 1, fig. 18.

This is not a very satisfactory specimen upon which to base any conclusions, and it seems wiser to merely refer it provisionally to this species without comment or discussion.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Juniperus hypnoides Heer.

Pl. II, figs. 26 in part, 27b, 28; Pl. III, figs. 12–13a.

Juniperus hypnoides Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 47, pl. 44, figs. 3, 4; pl. 46, fig. 18; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 29, pl. 1, fig. 1; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Bull. New York Bot. Gard., vol. 2, 1902, p. 403, pl. 41, figs. 7, 7a.
Juniperus macilenta Heer. Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 54, pl. 10, fig. 7.

Remains of this delicate little conifer are abundant in the clays at Kreischerville, Staten Island, and in those of New Jersey. It is possible that among these

more than one species may be represented, and Newberry has referred certain specimens to *J. macilenta* Heer (loc. cit.), as may be found discussed in this monograph under *Dammara borealis* Heer (see p. 38), but I have been unable to consider them as distinct from *J. hypnoides*. In fact, I am inclined to think that these two species of *Juniperus* may very well be joined together, as the specific distinctions between them are more or less vague. The vertical range of both species is practically identical, but *macilenta* only has been recognized in the Old World.

Locality: Woodbridge, N. J., Pl. II, figs. 26 in part, 27b, 28. Specimens in Mus. New York Bot. Gard.

Kreischerville, Staten Island, Pl. III, fig. 12. Collected by Mr. William T. Davis. Specimen in Mus. Staten Island Assn. Arts and Sci.

Chappaquiddick, Marthas Vineyard, Pl. III, figs. 13, 13a. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Cone scale of a Conifer?

Pl. II, fig. 38.

This little cone scale is well defined, and yet it does not seem to be identifiable with that of any described species, and apparently should not be included with any of the cone scales described under the genus *Dammara*, but is somewhat suggestive of that of certain cycads.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Class ANGIOSPERMÆ.

Subclass MONOCOTYLEDONÆ.

Order PANDANALES.

Family TYPHACEÆ.

Typha sp.

Pl. VI, figs. 4–6.

Typha? Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 63, pl. 180, fig. 9.

These fragments apparently represent remains similar to those which it has been the custom of paleobotanists to refer to the genus *Typha*, mostly from Tertiary horizons.[a] Any attempt, however, either to describe or to identify our specimens specifically does not seem to be advisable.

Locality: Gay Head, Marthas Vineyard, Pl. VI, figs. 4, 5. Collected by David White. Specimens in U. S. Nat. Mus.

Lloyd Neck, Long Island, Pl. VI, fig. 6. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

[a] *Typha latissima* Al. Br. Lesq., Cret. and Tert. Fl., p. 141, pl. 23, figs. 4, 4a, etc.

Order GRAMINALES.

Family POACEÆ.

POACITES sp.

Pl. II, fig. 11 in part; Pl. VI, figs. 9–11.

Poacites? Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 63, pl. 180, figs. 2, 12; Bull. New York Bot. Gard., vol. 3, 1904, p. 411, pl. 73, fig. 1.

The fragments of linear, finely parallel-veined leaves, represented in our figures, are referred to the genus *Poacites* for the reason that most authorities, in describing similar remains from Cretaceous and Tertiary horizons, have included them under that generic name.[a] Any attempt at specific identification, however, would manifestly not be advisable.

Locality: Gay Head, Marthas Vineyard, Pl. II, fig. 11 in part. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. VI, figs. 9–11. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Family CYPERACEÆ.

CYPERACITES sp.

Pl. VI, figs. 7, 8.

Cyperites? Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 63, pl. 180, fig. 3.

These remains are apparently generically identical with numerous similar ones which have been described as species of *Cyperacites* or *Cyperites* from both Cretaceous and Tertiary horizons,[b] but satisfactory specific identification of our specimens is not possible.

Locality: Glen Cove, Long Island. Fig. 7 collected by David White. Specimen in U. S. Nat. Mus. Fig. 8 collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Order LILIALES.

Family LILIACEÆ.

MAJANTHEMOPHYLLUM PUSILLUM Heer.

Pl. VI, fig. 12.

Majanthemophyllum pusillum Heer, Fl. Foss. Arct., vol. 7, 1883, p. 18, pl. 55, figs. 17, 17b; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 36, pl. 1, fig. 7.

This specimen is retained in the systematic position in which it was originally included, not because of any conviction that this is correct, but largely to avoid change and possible confusion. It is apparently a fragmentary monocotyledonous leaf, very similar to Heer's species.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

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[a] *P. borealis* Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), p. 86, pl. 24, fig. 5; *P. mengeanus* Heer, Mioc. Balt. Fl., p. 59, pl. 15, figs. 2–11; *P. arundinarius* Etts., Foss. Fl. Bilin (pt. 1), p. 24, pl. 5, figs. 3–5, 16, etc.

[b] *Cyperacites arcticus* Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), p. 86, pl. 12, fig. 4b; *C. hyperboreus* Heer, ibid., pl. 24, figs. 4, 4b; *Cyperites deperditus* Wat., Fl. Foss. Bass. Paris, p. 69, pl. 18, fig. 3; *C. borealis* Heer, Fl. Foss. Arct., vol. 1, p, 96, pl. 45, figs. 3, 3b; *C. Haydenii* Lesq., Cret. and Tert. Fl., p. 140, pl. 23, figs. 1–3, etc.

Subclass DICOTYLEDONÆ.

Series I. CHORIPETALÆ.

Order SALICALES.

Family SALICACEÆ.

POPULUS HARKERIANA Lesquereux.

Pl. VII, fig. 31.

Populus harkeriana Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 44, pl. 46, fig. 4; Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 419, pl. 36, fig. 8.

I was at first inclined to question the positive identification of this specimen, on account of the uncertainty in regard to the character of the margin throughout. The portion which is preserved, however, as well as the other features of form and nervation, seems to leave but little doubt in regard to its identity.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

POPULUS? APICULATA Newberry.

Pl. VII, figs. 28, 29.

Populus? apiculata Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 65, pl. 15, figs. 3, 4; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 31, pl. 3, fig. 2.

The identity of our fig. 28 with this species may be questioned, on account of its fragmentary character, but fig. 29 presents all of the essential features of the species, which heretofore was not definitely known to occur elsewhere than in the Cretaceous of New Jersey.

Locality: Arrochar, Staten Island, Pl. VII, fig. 28. Collected by Gilman S. Stanton. Specimen in Mus. Staten Island Assn. Arts and Sci.

Glen Cove, Long Island, Pl. VII, fig. 29. Collected by David White. Specimen in U. S. Nat. Mus.

POPULUS STYGIA Heer?

Pl. VII, fig. 30.

Populus stygia Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 107, pl. 29, fig. 10.

This specimen, on account of its fragmentary character, must necessarily be referred with a query to Heer's species, although it matches it almost exactly. In both figures only the base of the leaf is preserved, and it must be admitted that this is indicative of a *Liriodendron* even more than it is of a *Populus*, and if it were not for the apparent identity with Heer's figure I should be inclined to regard it as belonging to the former genus and to compare it with *L. oblongifolium* Newb.[a]

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

[a] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), pl. 52, figs. 1-5.

Aments of populus sp.

Pl. VII, figs. 16–18.

"Ament * * * probably a *Salix* or a *Populus*," Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 63, pl. 180, fig. 6.

These rather questionable remains were found at both Gay Head and Glen Cove, and a few additional fragments are also included among the specimens not figured. They apparently represent dismembered catkins or aments and may be compared quite satisfactorily with those of *Populus*, although they have not been found closely associated with any leaves of that genus.

Locality: Glen Cove, Long Island, Pl. VII, fig. 16. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. VII, figs. 17, 18. Collected by David White. Specimens in U. S. Nat. Mus.

Salix membranacea Newberry.

Pl. VIII, figs. 10, 23.

Salix membranacea Newb., Annals New York Lyc. Nat. Hist., vol. 9, 1868, p. 19; Mon. U. S. Geol. Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, p. 59, pl. 2, figs. 5–8a; Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 66, pl. 29, Fig. 12.
Salix Mattewanensis Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 68, pl. 51, fig. 5 (?).

Although these specimens differ considerably in size and also in shape, these differences are no greater than are shown in Newberry's figures (loc. cit.). Our fig. 10 is comparable with Newberry's figs. 6 and 8 and our fig. 23 with Newberry's figs. 5, 7. I am inclined to think that two species may be represented by these two forms, but as it was Newberry's evident intention to include them under the one species I have done the same, although it is probable that our fig. 23 may ultimately be relegated to *S. mattewanensis* Berry, loc. cit.

Locality: Gay Head, Marthas Vineyard, Pl. VIII, fig. 10. Collected by David White. Specimen in U. S. Nat. Mus.

Kreischerville, Staten Island, Pl. VIII, fig. 23. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Salix cuneata Newberry.

Pl. VII, figs. 26, 27; Pl. VIII, fig. 7.

Salix cuneata Newb., Annals New York Lyc. Nat. Hist., vol. 9, 1868, p. 21; Mon. U. S. Geol. Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, p. 55, pl. 2, figs. 1, 2.
"*Salix*, sp.?" Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 32, pl. 2, fig. 16.
Myrica longa Heer, Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 419, pl. 38, fig. 6.

It is with some hesitation that I have decided to group these three specimens together under this species, as they present some slight differences in the angle of nervation and in their basal outlines, but similar slight differences may also be seen in the two specimens figured by Newberry. It may also be noted that our speci-

mens, especially fig. 26, bear a strong resemblance to the leaves referred by Lesquereux to *Myrica longa* Heer,[a] with which species I was at first inclined to include them.

Locality: Kreischerville, Staten Island, Pl. VII, fig. 26. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Arrochar, Staten Island, Pl. VII, fig. 27. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Glen Cove, Long Island, Pl. VIII, fig. 7. Collected by David White. Specimens in U. S. Nat. Mus.

Salix Meekii Newberry.

Pl. VIII, figs. 1c, 8, 9.

Salix Meekii Newb., Annals New York Lyc. Nat. Hist., vol. 9, 1868, p. 19; Mon. U. S. Geol. Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, p. 58, pl. 2, fig. 3; Hollick, Trans. New York Acad. Sci., vol. 16, 1897, p. 130, pl. 13, figs. 3, 4; Bull. New York Bot. Gard., vol. 2, 1902, p. 404, pl. 41, fig. 1.

Myrsine elongata Newb. Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 420, pl. 38, fig. 4c.

From the biological point of view the wisdom of attempting to maintain the specific or varietal rank of all the numerous described forms of *Salix* included in this monograph will doubtless be criticised, but for geological reasons it may be convenient at times to designate a certain form by a distinctive name and to compare it with a figure so named, from some particular locality or horizon. The fact should never be lost sight of that in stratigraphic work the positive identification of a specimen with a named figure is of far greater importance than the question whether the name represents its correct botanical relationships, and any change in nomenclature may often lead to serious confusion in this connection. By reason of these considerations I have therefore made as few changes in nomenclature as possible.

Locality: Arrochar, Staten Island, Pl. VIII, fig. 1c. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Chappaquiddick, Marthas Vineyard, Pl. VIII, fig. 8. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Nashaquitsa, Marthas Vineyard, Pl. VIII, fig. 9. Collected by David White. Specimen in U. S. Nat. Mus.

Salix proteæfolia flexuosa (Newberry) Lesquereux.

Pl. VIII, figs. 5, 6a; Pl. XXXVII, fig. 8b.

Salix proteæfolia var. *flexuosa* Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 50, pl. 64, figs. 4, 5; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 50, pl. 174, fig. 5; Annals New York Acad. Sci., vol. 11, 1898, p. 59, pl. 4, fig. 5a; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 67, pl. 48, fig. 12; pl. 52, fig. 2.

Salix flexuosa Newb., Annals New York Lyc. Nat. Hist., vol. 9, 1868, p. 21; Mon. U. S. Geol. Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, p. 56, pl. 2, fig. 4; pl. 13, figs. 3, 4; pl. 14, fig. 1.

Dewalquea Haldemiana (Deb.) Sap. et Mar. Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 36, pl. 2, figs. 2a, 10.

I am inclined to think that the recognition of this and other forms of *S. proteæfolia* by Lesquereux as varieties was hardly warranted by the slight differences

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), pl. 3, figs. 1-6.

which they present, and that in any revision of the genus these and perhaps some recognized species might be grouped together, but inasmuch as the several forms with which our specimens may be compared have been described and figured under different varietal or specific names, I have thought it best to so refer them in this monograph, which is essentially stratigraphic rather than biologic in its scope and purpose.

Locality: Sea Cliff, Long Island, Pl. VIII, fig. 5. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Black Rock Point, Block Island, Pl. VIII, fig. 6a. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Kreischerville, Staten Island, Pl. XXXVII, fig. 8b. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Salix proteæfolia lanceolata Lesquereux.

Pl. VIII, figs. 1a, 2–4.

Salix proteæfolia var. *lanceolata* Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 50, pl. 64, figs. 6–8; Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 59, pl. 4, fig. 4.

Salix proteæfolia Lesq. Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.

Salix inæqualis Newb.? Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 419, pl. 38, fig. 4a; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r49.

In connection with these figures the same or similar criticisms may be made as in connection with the discussions of other closely related forms of *Salix* included in this monograph, in which varietal and specific names are to be regarded more as convenient designations than as names which are necessarily botanically correct in their systematic arrangement.

Locality: Arrochar, Staten Island, Pl. VIII, fig. 1a. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Black Rock Point, Block Island, Pl. VIII, fig. 2. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. VIII, figs. 3, 4. Collected by David White. Specimens in U. S. Nat. Mus.

Salix proteæfolia linearifolia Lesquereux?

Pl. VIII, fig. 12.

Salix proteæfolia var. *linearifolia* Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 49, pl. 64, figs. 1–3.

It is exceedingly difficult to distinguish the differences between the several varietal forms included by Lesquereux in this species[a] and others referred to *Salix cuneata* Newb.[b] and *S. Meekii* Newb.,[c] and the specimen now under consideration might perhaps be regarded, by reason of its expanded base, as yet another variety or species. As, however, it is not perfect, I have thought that it would not be advisable to make it the basis for the description of a new form.

Locality: Gay Head, Marthas Vineyard. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] Var. *flexuosa*, loc. cit., p. 50, pl. 64, figs. 4, 5. Var. *lanceolata*, ibid., figs. 6–8. Var. *longifolia*, ibid., fig. 9.

[b] Mon. U. S. Geol. Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, pl. 2, figs. 1, 2.

[c] Ibid., pl. 2, fig. 3.

Salix purpuroides Hollick.

Pl. VIII, fig. 11.

Salix purpuroides Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 50, pl. 174, fig. 9.

This leaf, by reason of its small size, long tapering base, and relatively broad upper part, was regarded as worthy of a distinct specific designation. The type specimen here figured is the only one thus far found.

Locality: Sea Cliff, Long Island. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Salix sp.

Pl. VIII, fig. 13.

Salix, sp? Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 32, pl. 2, fig. 15.

This fragment is more than likely to be a portion of a leaf of some described species or variety of *Salix*, but it is too imperfect for more than a generic identification.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Order MYRICALES.

Family MYRICACEÆ.

Myrica Davisii Hollick.

Pl. VII, fig. 25.

Myrica Davisii Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 32, pl. 2, fig. 3.

This species, except in its smaller size, hardly differs from *Myrica longa* (Heer),[a] and might perhaps be identified with it, as may be seen by comparison with Heer's fig. 4 (loc. cit), but as our specimen was originally described under a distinct specific name I have not thought it advisable to make any change. The type specimen here figured is the only one thus far found.

Locality: Kreischerville, Staten Island. Collected by William T. Davis. Specimen in Mus. Staten Island Assn. Arts and Sci.

Myrica Hollicki Ward.

Pl. VII, fig. 24.

Myrica Hollicki Ward, Am. Jour. Sci., vol. 45, 1893, p. 437.
Myrica grandifolia Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 32, pl. 3, fig. 1. Not *M. grandifolia* (Ung.) Schimp., Pal. Vég., vol. 2, 1872, p. 559.

The type specimen of this species here figured is the only one thus far found, and, although imperfectly preserved, it shows well-marked characters sufficient to separate it from any other described species. The specific name originally applied to it was found to be preoccupied, and Dr. Lester F. Ward, who first noted this fact, proposed to substitute the name which is here adopted.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

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[a] *Proteoides longus* Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), p. 110, pl. 29, fig. 8b; pl. 31, figs. 4, 5.

Myrica Zenkeri (Ettingshausen) Velenovsky?

Pl. VII, fig. 23.

Myrica Zenkeri (Etts.) Vel., Fl. Böhm. Kreideform, part 2, 1883, p. 13 (38), pl. 3 (11), figs. 1-9.
Dryandroides Zenkeri Etts., Kreidefl. Niederschœna, 1867, p. 257, pl. 3, figs. 1, 3, 11.

Whatever may be thought of the identity of our fragment with the original figures of Ettingshausen (loc. cit.) there is no question that it bears a striking resemblance to some of the specimens figured by Velenovsky (loc. cit., figs. 3, 4), and also to some extent with *Celastrophyllum angustifolium* Newb.[a] In Newberry's discussion of this latter species, however, he refers to the figures of Ettingshausen and Velenovsky and says (loc. cit., p. 101): "Though perhaps generically identical—but rather as *Celastrophyllum* than *Myrica*—specifically our leaves are distinct."

Locality: Glen Cove, Long Island. Collected by David White. Specimen in U. S. Nat. Mus.

Ament of Myrica sp.

Pl. VII, fig. 22.

This organism apparently consists of an elongated aggregation of rounded, punctate or roughened fruits or seeds. These latter have much the appearance of *Carpolithes patootensis* Heer,[b] in regard to which he says (loc. cit.): "They belong perhaps to *Myrica*," and considers them as identical with similar seeds previously described as belonging to this genus.[c] The fact that our specimens appear to be rough, while Heer's are described as smooth, may, however, be due to the character of the matrix. Our specimen, although somewhat larger, bears also a striking resemblance to *Myricanthium amentaceum* Vel.,[d] especially when compared with his fig. 26 (loc. cit.), and to Heer's fruit of *Myrica* figured in Flora Fossilis Arctica, vol. 6 (abth. 2), pl. 46, fig. 26, and his *M. thulensis* in Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, pl. 31, fig. 1c.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Order JUGLANDALES.

Family JUGLANDACEÆ.

Juglans arctica Heer.

Pl. IX, figs. 6–8.

Juglans arctica Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 71, pl. 40, fig. 2; pl. 41, fig. 4c; pl. 42, figs. 1a, 1b, 2a, 2b; pl. 43, fig. 3; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 62, pl. 20, fig. 2; Hollick, Bull. Geol. Soc. Am., vol. 7; 1895, p. 13; Annals New York Acad. Sci., vol. 11, 1898, p. 58, pl. 3, fig. 7; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r49.
Ficus atavina Heer? Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 103, pl. 4, fig. 5.

This species and the one next considered are not very satisfactorily differentiated from each other by Heer, as may be seen by a comparison of his figures; and those who have attempted to identify specimens with one or another of these species

[a] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 100, pl. 14, figs. 8–17.
[b] Fl. Foss. Arct., vol. 7, 1883, p. 46, pl. 64, fig. 13.
[c] Kreide-Fl. Quedlinburg, 1872, p. 11, pl. 3, figs. 15–18.
[d] Abh. K. Böhm. Gesellsch. Wissensch., vol. 3 (Kvet. Cesk. Cenomanu), 1889, p. 16, pl. 2, figs. 24-26.

do not appear to have been entirely successful, as may be seen by comparing Heer's figures (loc. cit.) with those so referred by Lesquereux[a] and by Newberry (loc. cit.), although the latter, it should be noted, made the identification provisional only. Fig. 8 is apparently a portion of an ament, such as are figured by Heer (loc. cit., pl. 42, figs. 1b, 2b), and included with the leaves under the same specific name. The difference, however, between these and the similar aments which he includes under *Myrica longa*[b] is very slight, and they may all belong to the same species.

Locality: Tottenville, Staten Island, Pl. IX, fig. 6. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Nashaquitsa, Marthas Vineyard, Pl. IX, fig. 7. Collected by David White. Specimen in U. S. Nat. Mus.

Black Rock Point, Block Island, Pl. IX, fig. 8. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Juglans crassipes Heer.

Pl. IX, figs. 3–5.

Juglans crassipes Heer, Neue Denkschr. Schw. Gesellsch. Naturwissensch., vol. 23 (Fl. Moletein), 1869, p. 23, pl. 6, fig. 3; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 51, pl. 175, fig. 3.
Juglans arctica Heer? Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 51, pl. 178, fig. 2.

These specimens, while they do not compare very satisfactorily with Heer's type figures (loc. cit.), or with the specimens subsequently figured,[c] are apparently identical with those referred to this species by Lesquereux.[d]

Locality: Brooklyn, Long Island, Pl. IX, fig. 3. Collected by G. Hurst. Specimen in Mus. Long Island Hist. Soc.

Gay Head, Marthas Vineyard, Pl. IX, fig. 4. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. IX, fig. 5. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Juglans elongata n. sp.

Pl. XI, figs. 3, 4.

Laurus Omallii Sap. et Mar., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 52, pl. 176, fig. 3.

Leaf about 2 decimeters long, narrowly ovate-lanceolate in outline, slightly unsymmetrical and rounded at the base, tapering to the apex; margin entire and somewhat sinuous; midrib strong, somewhat flexuous, and curved at the base; secondary nerves numerous, forming angles of about 45° with the midrib, somewhat more obtuse near the base, curving rather sharply and extending upward near the margin where the extremities thin out and anastomose; tertiary nervation mostly irregular and branching, but in general at nearly right angles to the secondaries throughout.

This is apparently a well-defined species of *Juglans* which is different from any Cretaceous species heretofore described, but is strikingly similar to *J. Schimperi* Lesq.,[e] especially when compared with specimens described and figured by me from

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), pl. 19, fig. 3; pl. 39, fig. 5.
[b] Fl. Foss. Arct., vol. 6 (abth. 2), pl. 41, fig. 4b.
[c] Fl. Foss. Arct., vol. 7, pl. 61, fig. 4; pl. 65, fig. 9.
[d] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), pl. 49, figs. 1–3.
[e] Tert. Fl., p. 287, pl. 56, figs. 5–10.

the Eolignitic of Louisiana.[a] It is possible that the leaf which Newberry refers provisionally to *J. arctica* Heer, from the Cretaceous of New Jersey,[b] may represent a broad leaflet of our species, but their identity is too uncertain to warrant anything more than incidental mention.

Locality: Sea Cliff, Long Island, Pl. XI, fig. 3. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XI, fig. 4. Collected by David White. Specimen in U. S. Nat. Mus.

Order FAGALES.

Family FAGACEÆ.

QUERCUS MORRISONIANA Lesquereux.

Pl. VIII, fig. 14.

Quercus Morrisoniana Lesq., Cret. and Tert. Fl., 1883, p. 40, pl. 17, figs. 1, 2; Hollick, Trans. New York Acad. Sci., vol. 16, 1897, p. 131, pl. 13, figs. 11, 12; Bull. New York Bot. Gard., vol. 3, 1904, p. 411, pl. 73, fig. 5.

This well-defined Dakota group species is represented in our collections by the single specimen here figured, although it has been found in the clay marl at Cliffwood, N. J. I am inclined to believe that I have also identified it in certain specimens from the Amboy clays, but am not sufficiently certain in this respect to include it in the table of distribution for that horizon.

Locality: Center Island, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

QUERCUS (?) NOVÆ-CÆSAREÆ Hollick.

Pl. VIII, figs. 15, 16.

Quercus (?) *Novæ-Cæsareæ* Hollick, Trans. New York Acad. Sci., vol. 16, 1897, p. 131, pl. 13, figs. 9, 10; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 72, pl. 51, fig. 4 [?].

It is unfortunate that both of our specimens, as well as the type specimens from Cliffwood, N. J., are imperfect, none of them showing the characters of the apex; but the general outline, base, and nervation are all identical, and there can be no question that all should be included under one species, so far as may be judged from the characters that are preserved. The question of generic relationship is one which may very well be left open, however, and the reference to *Quercus* be regarded as provisional only.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

QUERCUS sp.

Pl. VIII, fig. 17.

This specimen is apparently a portion of an oak leaf, or possibly of a *Platanus*, but it is too fragmentary for any more exact determination.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Geol. Survey Louisiana, Rept. 1899 (1900), Special Rept. No. 5, p. 280, pl. 32, fig. 5; pl. 33, figs. 1, 2; pl. 35, fig. 3.

[b] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), p. 62, pl. 20, fig. 2.

Order URTICALES.

Family ULMACEÆ.

PLANERA BETULOIDES n. sp.

Pl. VIII, fig. 22.

Leaf elliptical-ovate in outline, 6.5 centimeters long by 2.3 centimeters wide in the middle, coarsely crenate-dentate above, entire below; secondary nervation alternate, sparse, diverging from the midrib at acute angles and terminating in the marginal dentitions, lower pair branched from beneath, the branches terminating in the lower dentitions.

This specimen, although larger, is similar in its general appearance to *Planera Knowltoniana* Hollick,[a] and is almost exactly comparable, except in size, with *Betula tremula* Heer,[b] as may be seen by comparing our specimen with the enlarged figure of the latter species (loc. cit., fig. 9).

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Family MORACEÆ.

FICUS MYRICOIDES Hollick.

Pl. XI, figs. 8, 9.

Ficus myricoides Hollick in Newb. Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 71, pl. 32, fig. 18; pl. 41, figs. 8, 9.

It is with some hesitation that I have decided to refer these specimens to this species, especially when comparing the base of our fig. 9 with the corresponding part of Newberry's fig. 18 (loc. cit.); but inasmuch as this latter figure was included with some doubt in the species (loc. cit.), and the other figures compare with ours quite satisfactorily, the reference appears to be justified.

Locality: Gay Head, Marthas Vineyard, Pl. XI, fig. 8. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XI, fig. 9. Collected by David White. Specimen in U. S. Nat. Mus.

FICUS FRACTA Velenovsky.

Pl. XI, fig. 7.

Ficus fracta Vel., Fl. Böhm. Kreideform., pt. 4, 1885, p. 10 (71), pl. 8 (31), fig. 15.
Aralia transversinervia Sap. et Mar., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 54, pl. 176, fig. 1.

This is apparently the only record of the occurrence of this species in America, but a comparison with Velenovsky's figure seems to justify the reference, and the geologic horizon from which his species was obtained is known, by reason of other unquestioned species, to be the approximate geologic equivalent of that in which ours was found.

Locality: Oak Neck, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896) p. 69, pl. 42, figs. 1–4.
[b] Fl. Foss. Arct., vol. 7, p. 21, pl. 53, fig. 1c; pl. 55, fig. 9.

Ficus atavina Heer.

Pl. X, figs. 4–6.

Ficus atavina Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 69, pl. 11, figs. 5b, 7b, 8b; pl. 17, fig. 8b; pl. 19, fig. 1b; pl. 20, figs. 1, 2; Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 75, pl. 1, figs. 8, 9; pl. 3, fig. 6.,
Ficus protogæa Heer., Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 108, pl. 29, fig. 2b; pl. 30, figs. 1–8 (not *F. protogæa* Ettingshausen, Sitzb. Akad. Wiss. Wien, Math.-Naturw. Cl., vol. 55, 1867, p. 249, pl. 2, fig. 5); Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 51, pl. 175, fig. 4.

This well-defined species of *Ficus* was originally called *F. protogæa* by Heer; but inasmuch as Ettingshausen had previously used the name for an apparently different species Heer subsequently renamed his species *F. atavina*, acknowledging his oversight in the matter. The species is common to the Atane and Patoot beds of Greenland, and it has been found on Marthas Vineyard, Long Island, and at Cliffwood, N. J. So far as our present knowledge is concerned its distribution seems to be confined to Greenland and eastern North America.

Locality: Gay Head, Marthas Vineyard, Pl. X, figs. 4, 5. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. X, fig. 6. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Ficus Krausiana Heer.

Pl. IX, fig. 9; Pl. X, figs. 1–3.

Ficus Krausiana Heer, Neue Denkschr. Schw. Gesellsch. Naturwissensch., vol. 23 (Fl. Moletein), 1869, p. 15, pl. 5, figs. 3–6; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Annals New York Acad. Sci., vol. 11, 1898, p. 59, pl. 3, fig. 1.
Ficus atavina Heer? Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 103, pl. 4, figs. 4, 6.

This species is hardly separable from *F. Beckwithii* Lesq.,[a] and in some specimens it is almost impossible to determine to which species they should be referred. For this reason I have included all of ours under the older specific name.

Locality: Tottenville, Staten Island. Pl. IX, fig. 9; Pl. X, fig. 3. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Gay Head, Marthas Vineyard, Pl. X, fig. 1. Collected by David White. Specimen in U. S. Nat. Mus.

Southeast Point, Block Island, Pl. X, fig. 2. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Ficus sapindifolia Hollick.

Pl. XI, figs. 1, 2.

Ficus sapindifolia Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 411, pl. 78, fig. 5.

This species has some of the characters of *Ficus magnoliæfolia* Lesq.,[b] but is more unsymmetrical and in this respect is suggestive of the genus *Sapindus*, as indicated in the specific name. It may also be seen to have certain points of resemblance to *F. Beckwithii* Lesq.,[c] but is broader and has a more robust midrib. The type specimen is represented by our fig. 1.

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[a] Cret. and Tert. Fl., p. 46, pl. 16, fig. 5; pl. 17, figs. 3, 4.
[b] Cret. and Tert. Fl., p. 47, pl. 17, figs. 5, 6.
[c] Cret. and Tert. Fl., p. 46, pl. 16, fig. 5; pl. 17, figs. 3, 4.

Locality: Mott Point, Manhassett Neck, Long Island, Pl. XI, fig. 1. Collected by A. E. Anderson. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XI, fig. 2. Collected by David White. Specimen in U. S. Nat. Mus.

Ficus Willisiana Hollick.

Pl. IX, figs. 1, 2.

Ficus Willisiana Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 52, pl. 176, figs. 2, 5; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r49.

These two figures are reproductions of the original figures of the type specimens, which are the only ones thus far discovered. The leaf was evidently one of the largest in the entire insular flora, so far as known, and it is unfortunate that the fragmentary nature of the specimens give us merely an indication of the actual size of the leaf, which apparently was not less than 8 inches in length.

Locality: Sea Cliff, Long Island, Pl. IX, fig. 1. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. IX, fig. 2. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Ficus Woolsoni Newberry?

Pl. XI, figs. 5, 6.

Ficus Woolsoni Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 70, pl. 20, fig. 3; pl. 23, figs. 1–6; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 33, pl. 2, fig. 1; Annals New York Acad. Sci., vol. 11, 1898, p. 419, pl. 37, fig. 9; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 74, pl. 47, fig. 7.

These fragmentary specimens are referred provisionally to this species, largely for the want of a better place in which to put them; it is evident, however, that this reference must be regarded as purely tentative.

Locality: Kreischerville, Staten Island, Pl. XI, fig. 5. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Tottenville, Staten Island, Pl. XI, fig. 6. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Order PROTEALES.

Family PROTEACEÆ.

Proteoides daphnogenoides Heer.

Pl. XII, figs. 1–5.

Proteoides daphnogenoides Heer, Nouv. Mem. Soc. Helv. Sci. Nat., vol. 22, No. 1 (Phyll. Crét. Nebr.), 1867, p. 17, pl. 4, figs. 9, 10; Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 99, pl. 3, figs. 1, 2; Bull. Torrey Bot. Club, vol. 21, 1894, p. 52, pl. 177, fig. 1; Ries, Sch. Mines Quart., vol. 15, 1894, p. 354; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 72, pl. 17, figs, 8, 9; pl. 32, figs. 11, 13, 14; pl. 33, fig. 3; pl. 41, fig. 15.

Many of the numerous leaf forms which have been referred to this species from time to time by different authorities seem somewhat questionable when comparison is made with Heer's original figures (loc. cit.), but there is no doubt that our specimens are identical with several which have been so referred,[a] and it would not be

[a] Lesquereux, Cret. Fl., pl. 15, figs. 1, 2; Newberry, Fl. Amboy Clays, pl. 17, fig. 9; pl. 32, fig. 13, etc.

advisable now to disturb these references and thus to cause confusion. I am also inclined to think that the leaf which Lesquereux calls *Ficus proteoides*[a] should be included with this species and all perhaps be placed in the genus *Ficus*. This change, however, would necessarily lead to an extended revision and rearrangement which would be out of place in this work. Mr. Edward W. Berry has discussed the subject in a recent paper on "A *Ficus* confused with *Proteoides*,"[b] in which views similar to the above are expressed and the change of name to *Ficus daphnogenoides* (Heer) is definitely proposed, but from the practical point of view of the geologist the fact of identity between specimens is of far greater importance than the determination of their probable botanical affinities.

Even if all the doubtful forms should be excluded, however, there would yet remain a large number identical with each other—sufficient to indicate that the species was a widely distributed and important element in the Cretaceous flora of North America. Mr. Berry has included in the species a number of specimens found in the clay marl at Cliffwood, N. J.,[c] but their identity with what I regard as representative specimens of the species as now recognized appears to be open to question.

Locality: Tottenville, Staten Island, Pl. XII, figs. 1, 2. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Gay Head, Marthas Vineyard, Pl. XII, figs. 3, 4. Collected by David White. Specimens in U. S. Nat. Mus.

Sea Cliff, Long Island, Pl. XII, fig. 5. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Dryandroides quercinea Velenovsky.

Pl. VIII, figs. 18, 19.

Dryandroides quercinea Vel., Fl. Böhm. Kreideform., pt. 2, 1883, p. 8 (33), pl. 2 (10), figs. 8a–15.

These specimens do not compare satisfactorily with all of Velenovsky's figures, but they are sufficiently like his fig. 12 (loc. cit.) to warrant the reference. They may also perhaps be compared with *Dryophyllum* (*Quercus*) *Holmesii* Lesq.,[d] except that in ours the dentition is coarser.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Banksites Saportanus Velenovsky.

Pl. VIII, figs. 20, 21.

Banksites Saportanus Vel., Fl. Böhm. Kreideform., pt. 2, 1883, p. 7 (32), pl. 1 (9), figs. 18–20.
Celastrophyllum Benedeni Sap. et Mar., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 58, pl. 177, fig. 3.

It is perhaps somewhat hazardous to attempt a definite identification from such fragments as those which are represented by our figures, especially as the species, so far as I am aware, has not been reported from elsewhere in America, but the close resemblance to Velenovsky's figures of specimens from the Cretaceous of Bohemia seems to justify the reference.

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[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 77, pl. 12, fig. 2.
[b] Bull. Torrey Bot. Club, vol. 32, 1905, pp. 327–330, pl. 21.
[c] Bull. New York Bot. Gard., vol. 3, 1903, p. 74, pl. 51, figs. 6–9.
[d] Cret. and Tert. Fl., p. 38, pl. 4, fig. 8.

Locality: Gay Head, Marthas Vineyard, Pl. VIII, fig. 20. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. VIII, fig. 21. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Order RANALES.

Family NYMPHÆACEÆ.

Nelumbo Kempii (Hollick) Hollick.

Pl. XIII, figs. 1–4; Pl. XIV, figs. 1, 2; Pl. XV; Pl. XVI, figs. 1–6.

Nelumbo Kempii (Hollick) Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 412, pl. 74, figs. 1, 2; pl. 75; pl. 76; pl. 77, fig. 1.

Serenopsis Kempii Hollick, Bull. Torrey Bot. Club, vol. 20, 1893, p. 169, pl. 149; ibid., p. 334, pl. 166; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r49.

When first described, the specimens upon which the descriptions were based were thought to represent a palm, and the generic name *Serenopsis* was given to them. The type figures are reproduced on Pl. XIII. Specimens subsequently discovered, however, showed beyond doubt that they were not a palm, but a species of *Nelumbo*, and that the species was similar to, if not identical with, *Nelumbium arcticum* Heer,[a] the figure of which is reproduced on Pl. XVI, fig. 7, for comparison. Considerable difference may be noticed between our specimens, but it hardly seems advisable to consider them otherwise than as belonging to a single species.

The only other representative of the genus which has been recorded from this vicinity is *N. primæva* Berry,[b] from the Cretaceous clay marl at Cliffwood, N. J., although Mr. Berry has informed me that he has found specimens, which he thinks may be identical with ours, from a lower horizon than that at Cliffwood, near Morgans, N. J.

Locality: Glen Cove, Long Island, Pl. XIII, figs. 1–4; Pl. XIV, figs. 1, 2; Pl. XV; Pl. XVI, fig. 6. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Manhassett Neck, Long Island, Pl. XVI, fig. 5. Collected by A. E. Anderson. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XVI, figs. 1–4. Collected by David White. Specimens in U. S. Nat. Mus.

Family MENISPERMACEÆ.

Menispermites Brysoniana Hollick.

Pl. XII, fig. 6.

Menispermites Brysoniana Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 59, pl. 180, fig. 10; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50.

The resemblance of this species to *Menispermites borealis* Heer[c] is quite apparent, but the imperfect condition of Heer's specimen renders exact comparison

[a] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 92, pl. 40, fig. 6.
[b] Bull. New York Bot. Gard., vol. 3, 1903, p. 75, pl. 43, fig. 1.
[c] Fl. Foss. Arct., vol. 6 (abth. 2), p. 91, pl. 39, fig. 2.

impossible. Our figure is a reproduction of the figure of the type specimen, which is the only one known to me.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Menispermites acutilobus Lesquereux?

Pl. XII, fig. 8.

Menispermites acutilobus Lesq., Cret. and Tert. Fl., 1883, p. 78, pl. 14, fig. 2.

The identity of our specimen with this species must necessarily be doubtful, on account of its imperfect condition, but that it is closely related to it there can hardly be any question.

Locality: Nashaquitsa, Marthas Vineyard. Collected by David White. Specimen in the U. S. Nat. Mus.

Menispermites sp.

Pl. XII, fig. 7.

Hedera sp.? Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 421, pl. 38, fig. 5.

This fragment is apparently referable to *Menispermites* rather than to *Hedera*, as originally thought probable, and might perhaps be considered as a small form of the species last described.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Cocculus minutus Hollick.

Pl. XII, fig. 9.

Cocculus minutus Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 407, pl. 70, fig. 6.

It is possible that this may be only a very small form of the species next described.

Locality: Little Neck, Northport Harbor, Long Island. Collected by Heinrich Ries. Specimen in Mus. New York Bot. Gard.

Cocculus cinnamomeus Velenovsky.

Pl. XII, figs. 10–12.

Cocculus cinnamomeus Vel., Fl. Böhm. Kreideform., pt. 4, 1885, p. 4 (65), pl. 8 (31), figs. 16–21.

Although our specimens are somewhat smaller than those figured by Velenovsky, their identity can hardly be questioned, except perhaps in regard to our fig. 12, in which the lateral nerves are indicated as starting from the midrib a short distance above the base. This slight difference, however, would scarcely seem to warrant us in regarding it as a different species.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Cocculites imperfectus n. sp.

Pl. XII, fig. 14.

Leaf linear-elliptical (?) in outline, about 5 centimeters (?) long by 1.5 centimeters maximum width; margin entire; nervation consisting of a midrib and two pairs of subparallel, equidistant lateral nerves, which start at the base of the leaf; tertiary nerves parallel to each other and at right angles to the lateral nerves.

It is possible that this specimen may represent a lower portion of a leaf of the species next described, but the disposition of the lateral nerves is slightly different and the angles between the tertiary and the lateral nerves appear to be more obtuse.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Cocculites inquirendus n. sp.

Pl. XII, fig. 13.

Leaf linear-elliptical (?) in outline, about 5 centimeters (?) long by 1.5 centimeters maximum width; margin entire; apex blunt; nervation acrodrome, consisting of a midrib and two pairs of subparallel lateral nerves near the margin, with subparallel tertiary nerves connecting the midrib with the inner lateral nerves and the lateral nerves with each other.

This fragment has many points in common with *Cocculites Kanii* (Heer) Heer,[a] although much smaller in size, and with *Menispermites ovalis* Lesq.,[b] and the question of generic reference appears to be merely a matter of personal choice.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Family MAGNOLIACEÆ.

Magnolia Capellinii Heer.

Pl. XVII, figs. 3, 4.

Magnolia Capellinii Heer, Nouv. Mem. Soc. Helv. Sci. Nat., vol. 22, No. 1, 1867 (Phyll. Crét. Nebr.), p. 21, pl. 3, figs. 5, 6; Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 234, pl. 6, fig. 6; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r49; Bull. New York Bot. Gard., vol. 3, 1904, p. 413, pl. 78, fig. 3.

There can be no question in regard to our specimens being identical with this well-defined species, which is not uncommon on Long Island, but has not been satisfactorily identified from elsewhere in this region, although it is listed by Lesquereux as having been found at Sayreville, N. J.,[c] and Berry describes and figures a fragment of a leaf from Cliffwood, N. J., as belonging to the species.[d] In connection with the former, however, Lesquereux says (loc. cit.): "These specimens are few and poor, and therefore the determinations are not positively ascertained," and the identity of the latter is very doubtful.

Locality: Glen Cove, Long Island, Pl. XVII, fig. 3. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Center Island, Long Island, Pl. XVII, fig. 4. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

[a] Fl. Foss. Arct., vol. 3 (Mioc. Fl. Arct. Zone), 1874, p. 21; ibid., vol. 7, 1883, p. 124, pl. 100, fig. 1b=*Daphnogene Kanii* Heer, ibid., vol. 1, 1868, p. 112, pl. 14, figs. 1–5; pl. 16, fig. 1=*Cocculus Kanii* (Heer) Sap. et Mar., Essai Veg. Marnes Heers. Gelind., 1873, p. 63, pl. 10, fig. 1.

[b] Ann. Rept. U. S. Geol. and Geog. Survey Terr., 1874 (1876), p. 357, pl. 5, fig. 4.

[c] Rept. Clay Deposits New Jersey, Geol. Survey New Jersey, 1878, p. 29.

[d] Bull. Torrey Bot. Club, vol. 31, 1904, p. 76, pl. 3, fig. 3.

Magnolia speciosa Heer.

Pl. XIX, figs. 1–4.

Magnolia speciosa Heer, Neue Denkschr. Schw. Gesellsch. Naturwissensch., vol. 23 (Kreide-Fl. Moletein), 1869, p. 20, pl. 7, fig. 1; pl. 9, fig. 2; pl. 10, figs. 1, 2; pl. 11, fig. 1; Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 234, pl. 7, fig. 4; Bull. Torrey Bot. Club. vol. 21, 1894, p. 60, pl. 178, fig. 5; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50; Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 76, pl. 3, fig. 10.

The specimens representing this species are among the most satisfactory which have been found within the insular area, and it is evident from the number of specimens included in the collections that the species was an important element in the flora. It is prominently identified with the Dakota group and also occurs in the clay marl of Cliffwood, N. J., but has not been found in the Amboy clays.

Locality: Glen Cove, Long Island, Pl. XIX, figs. 1, 2. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XIX, figs. 3, 4. Collected by David White. Specimens in U. S. Nat. Mus.

Magnolia tenuifolia Lesquereux.

Pl. XVII, fig. 1; Pl. XVIII, figs. 4, 5.

Magnolia tenuifolia Lesq., Am. Jour. Sci., vol. 46, 1868, p. 100; Cret. Fl., 1874, p. 92, pl. 21, fig. 1; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 77, pl. 47, fig. 10; Hollick, ibid., 1904, p. 413, pl. 73, fig. 2.

There is considerable difference between the robust specimen represented by our fig. 5, Pl. XVIII, and the more delicate specimens represented by the other two, but the same may be said of Lesquereux's figures,[a] and the general resemblance between all of them seems to justify the reference to this species.

Locality: Sea Cliff, Long Island, Pl. XVII, fig. 1. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. XVIII, fig. 4. Collected by David White. Specimen in U. S. Nat. Mus.

Gay Head, Marthas Vineyard, Pl. XVIII, fig. 5. Collected by David White. Specimen in U. S. Nat. Mus.

Magnolia longipes Newberry.?

Pl. XXI, figs. 5, 6.

Magnolia longipes Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 76, pl. 54, figs. 1–3; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 60, pl. 178, figs. 1, 3; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50.

These fragmentary specimens are not satisfactory subjects for accurate comparison, and they might be almost equally well included with *M. tenuifolia* Lesq.,[b] which differs but little from the species under consideration. In order that satisfactory comparison might be made, however, it would be necessary to have both the apex and petiole represented.

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[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, pl. 24, fig. 1, and Cret. Fl., 1874, pl. 21, fig. 1.

[b] Cret. Fl., 1874, pl. 21, fig. 1 and this monograph, Pl. XXVII, fig. 1; Pl. XXVIII, figs. 4, 5.

Locality: Glen Cove, Long Island, Pl. XXI, fig. 5. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Dosoris Island, Long Island, Pl. XXI, fig. 6. Collected by Bailey Willis. Specimen in Mus. New York Bot. Gard.

Magnolia pseudoacuminata Lesquereux.

Pl. XVIII, figs. 2, 3.

Magnolia pseudoacuminata Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 199, pl. 24, fig. 2.

I have found more or less difficulty, by reason of the fragmentary character of most of our specimens, in making a satisfactory distinction between this and the closely allied species *tenuifolia* and *amplifolia*. In fact, even in the more perfect specimens figured by Lesquereux [a] to represent the three species the specific distinctions are not very apparent.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Magnolia amplifolia Heer.

Pl. XVIII, fig. 1.

Magnolia amplifolia Heer, Neue Denkschr. Schw. Gesellsch. Naturwissensch., vol. 23 (Kreide-Fl. Moletein) 1869, p. 21, pl. 8, fig. 1; pl. 9, fig. 1.

This specimen, although unquestionably identical with Heer's species, as may be seen by comparison with his figures, more especially with his fig. 1, pl. 9 (loc. cit.), might readily be confused with certain allied species, as previously noted in my discussion of *M. pseudoacuminata* Lesq. The close similarity between these two species was also noted by Lesquereux,[b] who, however, regarded the thick midrib and curved apex of *amplifolia* as specifically distinguishing features, both of which are well shown in our specimen.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Magnolia Lacoeana Lesquereux.

Pl. XVII, fig. 2.

Magnolia Lacoeana Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 201, pl. 60, fig. 1; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 73, pl. 15, figs. 1, 2.

The broad, almost orbicular form of this leaf serves to identify it with this species, although it may be said that some forms referred by Heer to *M. Capellinii* are strikingly suggestive.[c] It is unfortunate that both in our specimen and in the one figured by Lesquereux the apex is wanting, which, however, he describes as "obtuse or abruptly pointed."

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, pl. 24, figs. 1–3.
[b] Ibid., p. 200.
[c] Fl. Foss. Arct., vol. 6 (abth. 2), pl. 24, fig. 3; pl. 45, fig. 1.

Magnolia longifolia Newberry.

Pl. XX, figs. 2, 3.

Magnolia longifolia Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 76, pl. 55, figs. 3, 5; pl. 56, figs. 1–4; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 36, pl. 3, fig. 9; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Annals New York Acad. Sci., vol. 11, 1898, p. 422, pl. 37, fig. 3; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50.

Our fig. 2 is manifestly too fragmentary for satisfactory identification, but fig. 3 is apparently a small form of the species and is comparable with the leaf from Woodbridge, N. J., doubtfully referred by Newberry to *M. alternans* Heer,[a] which, however, can hardly be included in that species.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Magnolia Isbergiana Heer.

Pl. XX, fig. 4.

Magnolia Isbergiana Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 91, pl. 36, fig. 3; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 60, pl. 178, fig. 4; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50.

This species is represented in our collections by the one specimen here figured, which appears to be the only one thus far brought to light other than the single type specimen from Greenland, figured by Heer (loc. cit.). The two figures are quite similar, although the type shows a wider base, thus giving to the leaf a more pyramidal shape than is indicated in ours.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Magnolia woodbridgensis Hollick.

Pl. XX, fig. 7.

Magnolia woodbridgensis Hollick, in Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 74, pl. 36, fig. 11; pl. 57, figs. 5–7; Trans. New York Acad. Sci., vol. 16, 1897, p. 133, pl. 14, fig. 8; Annals New York Acad. Sci., vol. 11, 1898, p. 60, pl. 3, fig. 2; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 77, pl. 53, fig. 5; pl. 57, fig. 2.

This specimen, although imperfect, is so exactly comparable with fig. 7, pl. 57 (Fl. Amboy Clays, loc. cit.), that they must be regarded as identical. It is the only representative of the species thus far found within the insular area, although the species is not uncommon in both the Amboy clays and the Cliffwood clay marls in New Jersey.

Locality: Balls Point, Block Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

[a] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), pl. 55, fig. 1.

Magnolia glaucoides Newberry?

Pl. XIX, fig. 6; Pl. XX, fig. 6.

Magnolia glaucoides Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 74, pl. 57, figs. 1–4; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 60, pl. 175, figs. 1, 7; Bull. Geol. Soc. Am., vol. 7. 1895, p. 13; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50.

It is unfortunate that in each of our specimens the upper part is missing, as this part would probably serve to determine whether we should regard them as belonging with this species or with *M. Boulayana* Lesq.,[a] which apparently differs from the former merely in having an acute instead of an obtuse apex. This specific distinction may not always hold good, however, as indicated by several specimens from New Jersey in the Museum of the New York Botanical Garden, and in any critical revision of the genus I am inclined to think that the two species would be united.

Locality: Sea Cliff, Long Island. Collected by Gilbert Van Ingen. Specimens in Mus. New York Bot. Gard.

Magnolia alternans Heer.

Magnolia alternans Heer, Nouv. Mem. Soc. Helv. Sci. Nat., vol. 22, No. 1 (Phyll. Crét. Nebr.), 1867, p. 20, pl. 3, figs. 2–4; pl. 4, figs. 1, 2; Pollard, Trans. New York Acad. Sci., vol. 13, 1894, p. 181.

This species is listed by Pollard (loc. cit.) as occurring at Elm Point, Great Neck, Long Island, but I have not seen the specimen.

Magnolia Van Ingeni Hollick.

Pl. XX, fig. 1.

Magnolia Van Ingeni Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 61, pl. 175, fig. 6.

This species, based upon a single specimen, the original figure of which is here reproduced, is somewhat similar in appearance to *M. glaucoides* Newb., as may be seen by comparing it with the figures of specimens so referred in this monograph on Pl. XIX, fig. 6, and Pl. XX, fig. 6, but the leaf is narrower, the base more rounded, and the angle of nervation more obtuse.

Locality: Sea Cliff, Long Island. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Magnolia auriculata Newberry.

Pl. XIX, fig. 5; Pl. XX, figs. 5, 8.

Magnolia auriculata Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 75, pl. 41, fig. 13; pl. 58, figs. 1–11; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 61, pl. 179, figs. 6, 7; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r49.

"Dicotyledonous leaf impression," Hitchcock, Geol. Massachusetts, vol. 2, 1841, p. 430, pl. 19, fig. 1 in part.

The identity of our specimens with this exceedingly variable species is perhaps open to question, although I have specimens from New Jersey, labeled by Doctor

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 202, pl. 60, fig. 2; pl. 65, fig. 2.

Newberry, which resemble ours more closely than any of those which he figured. It is interesting to note that a leaf from Gay Head figured by Hitchcock, to which, however, he did not give any name, unquestionably belongs to this species, as may be seen by comparing it[a] with Newberry's figures (loc. cit.).

Locality: Glen Cove, Long Island, Pl. XIX, fig. 5, Pl. XX, fig. 5. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XX, fig. 8. Collected by Edward Hitchcock.

Liriodendron oblongifolium Newberry?

Pl. XXI, fig. 8.

Liriodendron oblongifolium Newb., Bull. Torrey Bot. Club, vol. 14, 1887, p. 5, pl. 61, fig. 1; Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 81, pl. 52, figs. 1–5; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 62, pl. 179, fig. 3.

This specimen, while it has much the appearance of a median portion of a leaf of this species, is altogether too fragmentary for any but provisional reference, especially as it is the only specimen of this species in the insular flora collections.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Liriodendron primævum Newberry.

Pl. XXI, fig. 7.

Liriodendron primævum Newb., Annals New York Lyc. Nat. Hist., vol. 9, 1868, p. 12; Mon. U. S. Geol. Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, p. 96, pl. 6, fig. 7; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 35, pl. 3, fig. 4.

This single specimen, which fortunately, however, is well preserved, is all that we have to represent the species in any of the collections of Cretaceous plants from eastern North America. Both Heer[b] and Lesquereux[c] included this species with the unlobed, emarginate leaves which Newberry placed in the genus *Liriodendropsis*. His views in this connection may be found expressed in the Flora of the Amboy Clays[d] on pages 79, 80, and I have no hesitation in regarding his conclusions in this respect as valid.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Liriodendron attenuatum n. sp.

Pl. XXI, figs. 9–11.

Liriodendron primævum Newb., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 61, pl. 179, fig. 4.

Leaves obscurely 2-lobed, entire, rounded below to a wedge-shaped base, constricted above to an emarginate apex; secondary nerves numerous and fine, diverging from the midrib at acute angles, soon branching and forming an irregular network with the tertiary nerves.

The first specimen of this species discovered, represented by our fig. 9, was thought to be a form of *L. primævum* Newb. and was so described by me (loc. cit.),

[a] Reproduced in our Pl. XX, fig. 8.
[b] Fl. Foss. Arct., vol. 6 (abth. 2), p. 87.
[c] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 203.
[d] Mon. U. S. Geol. Survey, vol. 26.

but specimens subsequently found have made it seem advisable to regard them all as belonging to a distinct species, with the secondary nervation at a more acute angle of divergence from the midrib and with a more elongated or attenuated upper portion than in *L. primævum*.

In some respects these leaves are similar to some of those included in the genus *Liriodendropsis*, and it is possible that they may ultimately have to be so considered. Our fig. 11 is to be specially noted in this connection.

Locality: Glen Cove, Long Island, Pl. XXI, fig. 9. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XXI, figs. 10, 11. Collected by David White. Specimens in U. S. Nat. Mus.

Genus Liriodendropsis Newberry.

Genus *Liriodendropsis* Newberry gen. nov., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 82.

In this genus Newberry includes leaves of considerable variation in form which he originally described as a single species under *Liriodendron*[a], and says (loc. cit.):

> I have thought it best to distinguish by a new generic name a group of leaves which are numerous in the Amboy clays and the Atane beds of Greenland. They have been hitherto included in the genus *Liriodendron* by Professor Heer and myself; but while they are evidently related to the tulip tree, their simple ovate or lanceolate form, relatively small size, and strongly marked, reticulated nervation separate them into a group by themselves, possessing characters which seem to have more than a specific value.

Since the date Newberry wrote the above a large amount of new material has been collected, which includes not only many which are identical with those which he described, but others which, although differing in certain particulars, are so closely similar that they should all be regarded as at least generically related, although what the botanical relationship of the genus may be is a question which we are not yet in a position to answer, and it must be admitted that in this connection the new material, with its multiplicity of new forms, has added to our perplexity instead of assisting us in arriving at any satisfactory conclusion.

Heer considered certain leaves from the lower Atane beds of Greenland, identical with those subsequently included by Newberry under *Liriodendropsis simplex*,[b] to be varieties of *Liriodendron Meekii* Heer, and they were so described and figured by him, together with other forms which he regarded as allied, including *Liriodendron primævum* Newb., *Phyllites obcordatus* Heer, and *Leguminosites Marcouanus* Heer.[c] This segregation of species was criticised by Newberry in his discussion of the genus *Liriodendropsis* (loc. cit.), but the actual or possible relationship of most of them to *Liriodendron* was affirmed.

The question of the affinity of some of these forms with *Liriodendron* was discussed at some length by Theodor Holm in a paper entitled "Notes on the Leaves

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[a] *L. simplex*., Bull. Torrey Bot. Club, vol. 14, 1887, p. 6, pl. 42, figs. 2–4.

[b] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 83, pl. 19, figs. 2, 3; pl. 53, figs. 1–4, 7.

[c] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 87, pl. 18, fig. 4c; pl. 22, figs. 1a, 1b, 2–13; pl. 23, figs. 3–8; pl. 25, fig. 5a; pl. 45, figs. 13a, 13b.

of *Liriodendron,"*[a] in which he criticises their reference even to the Magnoliaceæ, and says (loc. cit., p. 33): "* * * there is good reason for considering some of the obcordate leaves as belonging to plants of a quite different family, namely, if we compare them with leaflets of the Leguminosæ."

The same author subsequently continued the discussion in a paper "On the Validity of Some Fossil Species of *Liriodendron,"*[b] in which he calls attention to a specimen figured by me, showing three leaves in close juxtaposition,[c] and pertinently remarks (loc. cit., p. 314): "* * * might we not then assume that they have been situated close together, as they were found in the rock? They seem, indeed, to have formed a trifoliate leaf, not unlike *Desmodium, Phaseolus,* and others. Their venation is much more like that of the Leguminosæ than of any known *Liriodendron.* Moreover we must not forget that notched leaves are not only common among the Leguminosæ, but exist in many genera of various families, e. g., *Zygophyllum, Passiflora, Akebia,* etc.—which might also be taken into consideration."

Leaves which are superficially indistinguishable from some of ours are described and figured by Bayer from the Cretaceous of Bohemia under the name *Bignonia pulcherrima,*[d] and it is interesting to note that in his fig. 126a he shows three leaflets joined to a common petiole, thus forming a compound leaf. These figures are reproduced for comparison in our figures 2 and 3 on Pl. XXV, together with Newberry's type figure of *Liriodendropsis simplex* in fig. 1.

A number of other fossil leaves, which have been described from time to time under different genera, are impossible to separate from the general type represented in *Liriodendropsis.* As examples in this connection may be mentioned *Sapotacites retusus* Heer,[e] and *Myrsinophyllum varians* Vel.,[f] a figure of which is reproduced for comparison on Pl. XXV, fig. 6.

Finally, attention may be called to the interesting comparison made by Ward between certain forms of *Liriodendropsis simplex* and *Chondrophyton laceratum* Sap., from the Cretaceous of Portugal,[g] which latter he does not hesitate to rename *Liriodendropsis lacerata.*

In view, therefore, of the wide differences of opinion which have been expressed in regard to the probable botanical affinities of these leaf forms and the impossibility of separating one from another, except in the case of extreme forms, I have thought it advisable to include all of the specimens from our vicinity under the generic name *Liriodendropsis,* leaving it in the systematic position in which it was placed by the author and separating it into as few species as possible, although doubtless some authorities may be inclined to recognize additional species or varieties among the many forms figured.

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[a] Proc. U. S. Nat. Mus., vol. 13, 1890, pp. 15–35, pls. 4–9.

[b] Bot. Gaz., vol. 20, 1895, pp. 312–316, pl. 23.

[c] *Liriodendron simplex* Newb., Glen Cove, Long Island, N. Y. Trans. N. Y. Acad. Sci., vol. 12, 1893, pl. 5, fig. 2. See this monograph, Pl. XXIII, fig. 5.

[d] Studien Gebiete Böhm. Kreideform. (Perucer Schichten), 1900 (1901), p. 156, figs. 126a, 126b. (Fig. 126a reduced in size; fig. 126b nat. size.)

[e] Fl. Foss. Arct., vol. 7, p. 32, pl. 61, fig. 10.

[f] Kvet. Cesk. Cenomanu, p. 25, pl. 4, figs. 8, 9; pl. 5, fig. 12; pl. 6, figs. 10, 11.

[g] Sixteenth Ann. Rept. U. S. Geol. Survey, 1894–5 (1896), pt. 1, p. 540, pl. 107, figs. 6–8.

Liriodendropsis angustifolia Newberry.

Pl. XXVI, figs. 1a, 2–5.

Liriodendropsis angustifolia Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 84, pl. 53, fig. 8; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.
Liriodendron simplex Newb. in part, Bull. Torrey Bot. Club, vol. 14, 1887, p. 6, pl. 62, fig. 4.

This species may be regarded as occupying one extreme of the series of which *Liriodendropsis spectabilis* represents the other, with *L. simplex*, *L. retusa*, and *L. constricta* as intermediate forms. Newberry's type figure is reproduced on Pl. XXVI, fig. 4.

It may appear to be just as difficult to draw the line between this species and some of those included under *L. constricta* as between any two other forms, but in maintaining them as distinct I believe that I am following the course which would have been pursued by Doctor Newberry if he had had the material in hand when he decided to recognize the species *simplex* and *angustifolia*.

Locality: Gay Head, Marthas Vineyard, Pl. XXVI, figs. 1a, 3. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXVI, fig. 2. Collected by David White. Specimen in U. S. Nat. Mus.

Woodbridge, N. J., Pl. XXVI, figs. 4, 5. Specimens in Mus. New York Bot. Gard.

Liriodendropsis constricta (Ward var.).

Pl. XXII, fig. 7; Pl. XXVI, figs. 6–15; Pl. XL, fig. 15.

Liriodendropsis simplex constricta Ward, Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1894–95 (1896), p. 540, pl. 107, fig. 8.
Liriodendron simplex Newb., Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 235, pl. 7, fig. 3.

Leaves entire, varying between 4 and 9 centimeters in length by 2 to 3.5 centimeters in maximum width, ovate-lanceolate in outline, wedge-shaped at the base, abruptly constricted or narrowed and almost linear in the upper part, with an emarginate or truncate apex; secondary and tertiary nervation almost indistinguishable one from the other, forming a fine network of elongated and polygonal areolæ.

I have included in this species the specimens in which the upper part is narrowed or abruptly constricted. The leaf which I regard as the type of the species is shown on Pl. XXVI, fig. 15, while figs. 7–11 are indicative of relationship with *L. angustifolia* and *L. simplex*.

With considerable hesitation I have also decided to include the specimen represented on Pl. XL by fig. 15, which may be merely an abnormal form of the species, and that represented on Pl. XXII by fig. 7, which is a form more or less suggestive of *L. spectabilis*.

Locality: Gay Head, Marthas Vineyard, Pl. XXII, fig. 7; Pl. XXVI, figs. 6–14; Pl. XL, fig. 15. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXVI, fig. 15. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Liriodendropsis retusa (Heer) n. comb.

Pl. XXV, figs. 8, 9.

Sapotacites retusus Heer, Fl. Foss. Arct., vol. 7, 1883, p. 32, pl. 61, fig. 10; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 123, pl. 53, figs. 5, 6.
Liriodendron simplex Newb. Hollick., Trans. New York Acad. Sci., vol. 12, 1893, p. 235, pl. 5, fig. 5.

I can see no valid reason for regarding the leaves represented by these specimens as generically distinct from the others with notched apices, referred to *Liriodendropsis*, and in fact they might even be included in some one or another of the described species of that genus, but Newberry considered the form represented by our two specimens here figured to be distinct. Whether the distinctive features should be regarded as generic, specific, or varietal is largely a matter of personal choice and convenience.

Locality: Woodbridge, N. J., Pl. XXV, fig. 8. Specimen in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. XXV, fig. 9. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Liriodendropsis simplex (Newberry) Newberry.

Pl. XXIII, figs. 1–7; Pl. XXIV, figs. 1–9; Pl. XXV, figs. 1, 4, 5, 7, 10–12; Pl. XXVI, figs. 1b, 1c, 1d.

Liriodendropsis simplex Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 83, pl. 19, figs. 2, 3; pl. 53, figs. 1–4, 7; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.
Liriodendron simplex Newb. in part, Bull. Torrey Bot. Club, vol. 14, 1887, p. 6, pl. 62, figs. 2, 3; White, Am. Jour. Sci., vol. 39, 1890, p. 98, pl. 2, figs. 6, 7; Uhler, Trans. Maryland Acad. Sci., vol. 1, 1892 (1901), p. 207; Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 99, pl. 2, figs. 2, 4, 5, 7, 9; Ibid., vol. 12, 1893, p. 235, pl. 5, figs. 1, 2, 4; pl. 7, fig. 2; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50; Pollard, Trans. New York Acad. Sci., vol. 13, 1894, p. 180.

It is with some hesitation that I have included all these leaf forms in this one species, and it is impossible to know whether the author of the species would have done so, but any attempt to separate them, even into varieties, seems hopeless, on account of the large number which it would be impossible to differentiate satisfactorily; and in this connection it may be remarked that not nearly all the specimens available have been figured.

When the relatively coarse secondary nervation only is preserved the leaves present quite a different appearance to those in which the finer intermediate nervation also is apparent. In the latter case the entire system of nervation is so interlaced that the distinction between coarser and finer nerves is often difficult to discern.

Another feature also of the nervation, to which Newberry did not call attention, is the quite considerable variation in the angle of divergence from the midrib. In those leaves which are symmetrical or nearly so, the angle is practically uniform, while in those which are irregular in outline the angle varies from about 45 degrees to almost a right angle in the same leaf, according to the position of the marginal inequalities.

However we may regard them, it is evident that these leaves represent one or more of the most abundant elements in the Cretaceous flora of this region, and if

it should be proven that they are identical with similar leaves from other localities, with which they have been compared, we have in them a type of vegetation that was world-wide in its distribution.

The forms which I regard as typical of the species as defined and figured by Newberry are shown on Pl. XXIV, figs. 4-9, together with three of Newberry's type figures (figs. 1-3) and another on Pl. XXV, fig. 1.

Locality: Gay Head, Marthas Vineyard, Pl. XXIII, figs. 1, 2, 3; Pl. XXV, figs. 4, 10, 11, 12; Pl. XXVI, figs. 1b, c, d. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXIII, figs. 4, 5; Pl. XXIV, figs. 4, 8, 9; Pl. XXV, fig. 5. (Fig. 4, Pl. XXIII, fig. 4, Pl. XXIV, collected by David White; specimens in U. S. Nat. Mus.; fig. 5, Pl. XXIII; figs. 8, 9, Pl. XXIV; fig. 5, Pl. XXV, collected by Arthur Hollick, specimens in Mus. New York Bot. Gard.)

Tottenville, Staten Island, Pl. XXIII, fig. 7; Pl. XXIV, figs. 5-7; Pl. XXV, fig. 7. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Woodbridge, N. J., Pl. XXIII, fig. 6; Pl. XXIV, figs. 1-3; Pl. XXV, fig. 1. Specimens in Mus. New York Bot. Gard.

Liriodendropsis spectabilis n. sp.

Pl. XXII, figs. 1–6.

Celastrophyllum decurrens Lesq.? Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 59, pl. 179, fig. 1.

Leaves lanceolate to ovate-lanceolate in outline, 1.1 to 1.45 decimeters in length by 5.5 centimeters maximum width, entire, emarginate at the apex; secondary and tertiary nervation almost indistinguishable one from the other, merging and forming a fine reticulated network of elongated and polygonal areolæ.

This species hardly differs from *L. simplex* except in size, and the decision to regard them as specifically distinct will doubtless be criticized; but so also would be a determination to group them together, especially if comparison were made between the extremes of size and shape in the two species.

Locality: Gay Head, Marthas Vineyard, Pl. XXII, figs. 1, 2, 4, 5. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXII, figs. 3, 6. (Fig. 3 collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard. Fig. 6 collected by David White. Specimen in U. S. Nat. Mus.)

Family ANONACEÆ.

Guatteria cretacea n. sp.

Pl. XXI, figs. 1-4.

Leaves varying in size from 7.5 centimeters to 1.5 decimeters in length by 2.5 centimeters to 4 centimeters in width, linear-lanceolate in outline, broadest just above the wedge-shaped, somewhat unsymmetrical base and tapering irregularly to the apex; margin entire and more or less sinuous; secondary nerves numerous, irregularly disposed, forming acute angles with the midrib, curving upward and anastomosing near their extremities.

These leaves are apparently different from any heretofore described, although our smallest one, represented by fig. 3, is almost indistinguishable from the lanceolate leaves included in fig. 4, pl. 62, in Lesquereux's Flora of the Dakota Group,

which is named "*Phyllites durescens* sp. nov." in the explanation of the plate. It is evident, however, that this figure was included in the species through some error, as it is not referred to in the descriptive text on page 218, and the specific description, while it agrees with the other figures (loc. cit., pl. 61, fig. 5; pl. 62, fig. 3), is impossible of application to the former.

Locality: Gay Head, Marthas Vineyard, Pl. XXI, figs. 1–3. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXI, fig. 4. Collected by David White. Specimen in U. S. Nat. Mus.

Family LAURACEÆ.

CINNAMOMUM CRASSIPETIOLATUM n. sp.

Pl. XXX, figs. 3, 4.

Leaves large, with thick, robust petioles about 3 centimeters in length; lateral nerves basilar, strong, with ascending secondaries on the outer sides and connected on the inner sides with the midrib by parallel, upward-bent cross nervation.

These specimens appear to belong to a large species of *Cinnamomum* with a conspicuously robust petiole, such as I have failed to find in connection with any species hitherto described.

Locality: Glen Cove, Long Island. Collected by David White. Specimens in U. S. Nat. Mus

CINNAMOMUM INTERMEDIUM Newberry.

Pl. XXIX, fig. 7; Pl. XXX, figs. 1, 2.

Cinnamomum intermedium Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 89, pl. 29, figs, 1–8, 10; Hollick, Fifty-fifth Ann. Rept., New York State Mus., 1901 (1903), p. r50.

Cinnamomum Sezannense Wat., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 53, pl. 180, figs. 5, 7; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50.

This species is closely similar in general appearance to some forms of *C. Scheuchzeri* Heer, *C. ellipsoideum* Sap. and Mar., and *C. sezannense* Wat., as noted by Newberry in his discussion (loc. cit.). My original identification was with the latter species, while Newberry, in discussing the resemblances and differences between his Amboy clay specimens and *C. ellipsoideum*, says: "If, however, they had been found in the same country and [in] beds of the same age, I should feel compelled to consider them as but forms of that species." The question of specific distinction, however, is secondary to the fact, which is apparently conclusive, that these specimens from Long Island are identical with those figured by Newberry from the Amboy clays of New Jersey.

Locality: Manhassett Neck, Long Island, Pl. XXIX, fig. 7. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. XXX, fig. 1. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Sea Cliff, Long Island, Pl. XXX, fig. 2. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Cinnamomum Heerii Lesquereux?

Pl. XXX, figs. 5, 6.

Cinnamomum Heerii Lesq., Am. Jour. Sci., vol. 27, 1859, p. 361; Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 105, pl. 15, fig. 1.

I have questioned the reference of our specimens to this species for the reason that they do not agree with Lesquereux's original figure,[a] although his subsequent figure in the Flora of the Dakota Group (loc. cit.) agrees essentially with ours. In almost every fossil species of the genus, however, a wide diversity in leaf form and point of origin of the secondary nerves has been recognized by those who have described them, and the difference in this instance is no greater than in many others. One character in our specimens, however, which might perhaps serve to separate them specifically, is the thin lateral nerves as compared with the relatively thick midrib and petiole.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Cinnamomum membranaceum (Lesquereux) n. comb.

Pl. XXIX, figs. 5, 6.

Paliurus membranaceus Lesq., Am. Jour. Sci., vol. 46, 1868, p. 101; Cret. Fl., 1874, p. 108, pl. 20, fig. 6.

The reference of these leaves to this species is made with but little hesitation, although ours are somewhat larger and in fig. 5 more elongated; but the variation in leaf forms displayed by many species of *Cinnamomum* is too well known to require comment, and that these leaves all belong in this genus rather than in *Paliurus* appears to be strongly indicated. Irregularity in outline and constriction in the upper part, indicating a tendency to lobation, is also characteristic of several species, and it is interesting to note that this tendency is well shown in a specimen referred by Lesquereux to *Cinnamomum sezannense* Wat.,[b] which might very well be considered as identical with ours. In all of these figures the lobation appears to be confined to one side of the leaf, as often seen in our living *Sassafras* and as shown in one figure of *S. subintegrifolium* Lesq.[c]

Locality: Glen Cove, Long Island. Collected by David White. Specimens in U. S. Nat. Mus.

Cinnamomum sp.

Pl. XXX, fig. 7.

This fragment apparently represents the base of a *Cinnamomum* leaf, with prominently suprabasilar lateral nerves. The slightly outward-curving margin may, however, indicate an irregular or lobate margin, and in that case the leaf would be suggestive of *Sassafras*, but it does not seem possible to connect it satisfactorily with any described species in either genus.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Trans. Am. Philos. Soc., vol. 13, 1869, pl. 23, fig. 12.
[b] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, pl. 12, fig. 6.
[c] Ibid., pl. 14, fig. 2.

Persea Leconteana (Lesquereux) Lesquereux.

Pl. XXXI, fig. 1.

Persea Leconteana (Lesq.) Lesq., Cret. Fl., 1874, p. 75, pl. 28, fig. 1.
Sassafras Leconteanum Lesq., Trans. Am. Philos. Soc., vol. 13, 1869, p. 431, pl. 23, fig. 1.

Although this is the only specimen of the species thus far reported from the Cretaceous of eastern North America, its identity seems to be quite satisfactory. The change in the generic name from *Sassafras* to *Persea*, by Lesquereux, is certainly to be commended.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Persea valida n. sp.

Pl. XXIX, figs. 8, 9.

Leaves about 1 decimeter long by 3 centimeters wide in the middle, linear-lanceolate in outline, tapering to a wedge-shaped base and rather abruptly to an acute apex; margins entire and irregularly wavy; midrib curved and flexuous above, straight or nearly so below; secondary nerves numerous, irregularly disposed and forming varying, mostly acute angles, with the midrib, especially below, curving upward and anastomosing near the margin.

These beautiful and well-defined leaves are hardly distinguishable from many of the leaf forms of the living *Persea pubescens* (Pursh) Sarg., and if found in one of the more recent geological horizons would probably be regarded as identical with that species.

Locality: Glen Cove, Long Island. Collected by David White. Specimens in U. S. Nat. Mus.

Ocotea nassauensis n. sp.

Pl. XXVII, fig. 8.

Leaf about 5.5 centimeters long, entire, obovate, constricted above to a narrow apex; nervation camptodrome; secondary nerves alternately disposed, about four on each side, diverging from the midrib at varying acute angles and curving upward along the margin.

This leaf is apparently different from any heretofore described, although it has some resemblance to the figure described as a terminal leaflet of *Sapindus diversifolius* Lesq.[a] The specific name is from Nassau, an old name for Long Island.

Locality: Glen Cove, Long Island. Collected by David White. Specimen in U. S. Nat. Mus.

Nectandra imperfecta n. sp.

Pl. XXVII, figs. 13, 14.

Leaves linear-ovate to linear-lanceolate in outline, entire, narrowed below to a wedge-shaped base; secondary nerves few, irregularly disposed, the lower ones extending upward at acute angles, the upper ones diverging from the midrib at more obtuse angles and connecting with the former through the short tertiary cross nervation in the upper part of the leaf.

It is unfortunate that these specimens are both imperfect, as they apparently represent a new and well-defined species in the Lauraceæ; but without the apex it is not possible to form a satisfactory idea of exactly what the leaves were like,

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 153, pl. 64, fig. 18 in part.

although the lower portions indicate relationship with *Nectandra* or some closely allied genus.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Sassafras acutilobum Lesquereux.

Pl. XXX, figs. 8, 9.

Sassafras acutilobum Lesq., Cret. Fl., 1874, p. 79, pl. 14, figs. 1, 2; Hollick, Trans. New York Acad. Sci., vol. 12 1893, p. 236, pl. 7, fig. 1; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Trans. New York Acad. Sci., vol. 16, 1897, p. 132, pl. 14, fig. 13; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 87, pl. 25, figs. 1–10; pl. 26, figs. 2–6; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 81, pl. 45, figs. 1, 2.

This exceedingly variable species is well represented by the extreme forms here figured, which, however, do not differ from each other any more than do those figured by Lesquereux (loc. cit.) and are not nearly so diverse as those depicted by Newberry from the Cretaceous of New Jersey (loc. cit.).

Locality: Gay Head, Marthas Vineyard, Pl. XXX, fig. 8. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXX, fig. 9. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Sassafras angustilobum n. sp.

Pl. XXIX, figs. 1–3.

Leaves palmately 3-lobed, entire, more or less decurrent below; lobes blunt pointed, narrow, linear wedge-shaped or slightly inflated about the middle; lateral primaries divergent, normally symmetrically suprabasilar, but occasionally with one lower than its opposite.

These leaves, except for their blunt lobes, might readily be taken for small specimens of the narrow forms of *Sassafras cretaceum* Newb.,[a] or *S. acutilobum* Lesq.[b] They are also suggestive of certain species of *Sterculia*, especially *S. Krejcii* Vel.,[c] and *S. aperta* Lesq.,[d] although in both of these species the lateral primaries are apparently strictly basilar.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Sassafras cretaceum Newberry?

Pl. XXX, fig. 10.

Sassafras cretaceum Newb., Annals New York Lyc. Nat. Hist., vol. 9, 1868, p. 14; Mon. U. S. Geol. Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, p. 98, pl. 6, figs. 1–4; pl. 7, figs. 1–3; pl. 8, figs. 1, 2.

This imperfect specimen apparently represents a lower part of some one of the broader leaf forms described and figured by Newberry under the above name, but any attempt to identify it with any particular form is ineffectual on account of its fragmentary condition.

Locality: Nashaquitsa, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Mon. U. S. Geol Survey, vol. 35 (Later Ext. Fl. N. Am.), 1898, pl. 7, fig. 1.
[b] Cret. and Tert. Fl., 1883, pl. 5, fig. 1.
[c] Fl. Böhm. Kreideform., pt. 2, 1883, p. 22 (47), pl. 5 (13), fig. 1.
[d] Cret. and Tert. Fl., 1883, p. 82, pl. 10, figs. 2, 3.

Sassafras hastatum Newberry?

Pl. XXIX, fig. 4; Pl. XXX, fig. 12.

Sassafras hastatum Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 88, pl. 27, figs. 4–6; pl. 28, figs. 1, 2; pl. 40, fig. 4; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 414, pl. 79, fig. 4.

The resemblance of these specimens to this species is indicated rather than expressed, and the absence of the bases in addition to the imperfect condition of the lobes makes positive identification impossible. The divergent character of the lobes is what has seemed to indicate identity with *hastatum* rather than with any other species of *Sassafras*, but it is quite possible that these specimens may belong with some species of *Aralia*, such as *A. grönlandica* Heer,[a] which is not uncommon in this region.

Locality: Gay Head, Marthas Vineyard, Pl. XXIX, fig. 4. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. XXX, fig. 12. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Sassafras progenitor Newberry.

Pl. XXX, fig. 11.

Sassafras progenitor Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 88, pl. 27, figs. 1–3; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 53, pl. 174, fig. 1; Bull. Geol. Soc. Am., vol. 7, 1895., p. 13; Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 78, pl. 1, fig. 3.

This specimen, which is the only one in our collection, may appear to be somewhat too fragmentary for positive identification, but the bulging margins of the lobes indicate relationship with this species rather than with any other. It is a common species in the Amboy clays and somewhat doubtful specimens have been found in the clay marl at Cliffwood, N. J.

Locality: Oak Neck, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Malapoenna sp.

Pl. XXXI, fig. 4.

This specimen, obviously too fragmentary for satisfactory specific identification or comparison, may belong with either *Litsea falcifolia* Lesq.[b] or with *L. cretacea* Lesq.,[c] although it appears to be too large for the former and too delicate for the latter, according to the only two published figures of these species. A perfect specimen of ours would apparently represent a form intermediate in appearance between these two.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

[a] Fl. Foss. Arct., vol. 6 (abth. 2), 1880, p. 84, pl. 38, fig. 3; pl. 39, fig. 1; pl. 46, figs. 16, 17.
[b] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 97, pl. 11, fig. 5.
[c] Ibid., p. 96, pl. 15, fig. 2.

Laurus nebrascensis (Lesquereux) Lesquereux.

Pl. XXVIII, figs. 3–8.

Laurus Nebrascensis (Lesq.) Lesq., Am. Jour. Sci., vol. 46, 1868, p. 98; Cret. Fl., 1874, p. 74, pl. 10, fig. 1; pl. 28, fig. 14.
Persea Nebrascensis Lesq., Trans. Am. Philos. Soc., vol. 13, 1869, p. 431, pl. 23, figs. 9, 10.
Laurus primigenia Ung.? Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 33, pl. 2, fig. 20; pl. 3, fig. 3.
Magnolia alternans Heer, Hollick, Bull. New York Bot. Gard., vol. 2, 1902, p. 405, pl. 41, figs. 4, 5.

Whatever may be thought of the fragmentary specimens represented by figs. 5–8, there can be but little doubt that figs. 3, 4 are referable to a form of this species, intermediate between the broad one shown in Lesquereux's fig. 1, pl. 10, and the narrow one depicted in fig. 14, pl. 28 (loc. cit.).

The fragmentary specimens were the first ones found by me, and they were somewhat doubtfully referred at that time in part to *Laurus* and in part to *Magnolia* (loc. cit.). The more perfect specimens subsequently brought to light, however, have afforded opportunity for more satisfactory comparison and identification, showing the characteristic thick midrib and obtuse apex of this species.

It is of interest to note that Lesquereux, in his discussion (loc. cit.) also refers to the resemblance between his specimens and certain species of *Magnolia*, particularly to *M. speciosa* Heer.[a]

Locality: Gay Head, Marthas Vineyard, Pl. XXVIII, figs. 3, 4. (Fig. 3 c lected by Arthur Hollick, specimen in Mus. New York Bot. Gard.; fig. 4 collected by David White, specimen in U. S. Nat. Mus.)

Chappaquiddick, Marthas Vineyard, Pl. XXVIII, figs. 5, 6. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Kreischerville, Staten Island, Pl. XXVIII, fig. 7. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Tottenville, Staten Island, Pl. XXVIII, fig. 8. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Laurus Newberryana Hollick.

Pl. XXXI, fig. 2.

Laurus Newberryana Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 52, pl. 179, fig. 5.

This species belongs in the same group with *L. teliformis* Lesq.,[b] and *L. Knowltoniana* Lesq.,[c] but it is much larger than the former and much less robust than the latter. The type specimen only is known, the figure of which is here reproduced.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] Neue Denkschr. Schw. Gesellsch. Naturwissensch., vol. 23 (Fl. Moletein), 1869, pl. 10, fig. 2.
[b] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 94, pl. 50, fig. 9.
[c] Ibid., fig. 4.

Laurus Hollae Heer?.

Pl. XXVIII, fig. 11.

Laurus Hollae Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 76, pl. 33, fig. 13; pl. 44, fig. 5b; pl. 45, fig. 3; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 34, pl. 2, fig. 17; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 78, pl. 50, figs. 7, 8; pl. 52, figs. 7, 8.

It is unfortunate that all of the specimens referable to this species which have thus far been found in this region are mere fragments, too imperfect for more than provisional identification.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Laurus antecedens Lesquereux.

Pl. XXVIII, figs. 9, 10.

Laurus antecedens Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 92, pl. 11, fig. 3.

Although our specimens are more rigid than the one figured by Lesquereux (loc. cit.), the resemblance between them is too marked to be disregarded, and it is evident, from the distorted condition of the margin, that Lesquereux's specimen does not represent the normal characters of the species.

Locality: Glen Cove, Long Island. Collected by David White. Specimens in U. S. Nat. Mus.

Laurus teliformis Lesquereux.

Pl. XXXI, fig. 3.

Laurus teliformis Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 94, pl. 50, fig. 9.

Our specimen is apparently identical with this species and differs from Lesquereux's figure (loc. cit.) merely in its wedge-shaped instead of acuminate apex. It is also strikingly like the leaf referred by Lesquereux to *Cinnamomum Scheuchzeri* Heer,[a] except that in ours the midrib is more delicate.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Laurus plutonia Heer.

Pl. XXVII, figs. 9, 10; Pl. XXVIII, figs. 1, 2.

Laurus plutonia Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 75, pl. 19, figs. 1d, 2–4; pl. 20, figs. 3a, 4–6; pl. 24, fig. 6b; pl. 28, figs. 10, 11; pl. 42, fig. 4b; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 85, pl. 16, figs. 10, 11; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Trans. New York Acad. Sci., vol. 16, 1897, p. 132, pl. 13, figs. 5, 6; Annals New York Acad. Sci., vol. 11, 1898, p. 60, pl. 4, figs. 6, 7; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 79, pl. 50, figs. 9–11; Bull. Torrey Bot. Club, vol. 31, 1904, p. 77, pl. 3, fig. 1.

This species has been made to include so many different forms that the reference to it of these specimens requires but brief comment. Heer's figures alone (loc. cit.)

[a] Cret. Fl., 1874, pl. 30, fig. 2.

embrace a wide diversity of leaf forms and these could be still further amplified by reference to numerous other authorities. As thus recognized the species has a wide geographical distribution, which includes Europe, Greenland, and the eastern and western United States.

Locality: Black Rock Point, Block Island, Pl. XXVII, figs. 9, 10. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. XXVIII, fig. 1. Collected by David White. Specimen in U. S. Nat. Mus.

Sea Cliff, Long Island, Pl. XXVIII, fig. 2. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Laurus angusta Heer.

Pl. XXVII, figs. 11, 12.

Laurus angusta Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 76, pl. 20, figs. 1b, 7; pl. 43, fig. 1c; Ries, Sch. Mines Quart., vol. 15, 1894, p. 354; Hollick, Bull. New York Bot. Gard, vol. 3, 1904, p. 408, pl. 70, figs. 10, 11.

Some of the forms of this species are hardly to be distinguished from the narrow forms of *L. plutonia;* but if the species is to be recognized there is no doubt that our specimens may be so referred.

Locality: Little Neck (Northport Harbor), Long Island. Collected by Heinrich Ries. Specimen in Mus. New York Bot. Gard.

Laurophyllum elegans n. sp.

Pl. XXVII, figs. 1–5.

Laurus plutonia Heer. Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 99, pl. 3, figs. 3, 4; ibid., vol. 12, 1893, p. 236, pl. 6, fig. 1.

Proteoides daphnogenoides Heer. Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 420, pl. 36, fig. 2.

Leaves linear-elliptical in outline, flexuous, 1.3 decimeters long by 2–2.4 centimeters wide at about the middle, entire, terminating above in a curved, attenuated, pointed apex and below in a long, narrow, pointed base; secondary nerves fine and numerous, the lower ones forming acute angles with the midrib, becoming more divergent above, curving and anastomosing near the margin; tertiary nervation mostly at right angles to the secondary nerves throughout.

The first of these leaves that were found were thought to be forms of *Laurus plutonia* Heer, but subsequent discoveries indicated beyond a doubt that they represented a distinct and well-defined species, closely similar to *Laurophyllum angustifolium* Newb.,[a] and differing but little, except in size, from *Laurus angusta* Heer.[b]

Locality: Tottenville, Staten Island, Pl. XXVII, figs. 1, 3–5. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Glen Cove, Long Island, Pl. XXVII, fig. 2. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

[a] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 86, pl. 17, figs. 10, 11.

[b] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 76, pl. 20, figs. 1b, 7; pl. 43, fig. 1c.

Laurophyllum nervillosum n. sp.

Pl. XXVII, figs. 6, 7.

Proteoides daphnogenoides Heer, Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 420, pl. 36, figs. 1, 3.

Leaves linear-elliptical in outline, about 1.5 decimeters long by 2.6 centimeters maximum width, entire, narrowed to a long wedge-shaped base; secondary nervation close, fine, uniformly divergent from the midrib throughout, flexuous, ultimately thinning out and merging into the tertiary nervation near the margin.

These specimens were formerly regarded by me as probably belonging to *Proteoides daphnogenoides* Heer, largely by reason of their similarity to a specimen from the Cretaceous of New Jersey, so identified by Newberry;[a] but I am now satisfied that this reference was erroneous and that they represent a lauraceous species, not unlike *Laurophyllum lanceolatum* Newb.,[b] but possessing a remarkably well-defined though delicate system of nervation which is absent, or perhaps was not present, in the specimens upon which the latter species was based. It is evident that the distinction between this and the three species last described is more easily indicated in the figures than expressed in words.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Order ROSALES.

Family PLATANACEÆ.

Platanus aquehongensis Hollick.

Pl. XXXI, fig. 6.

Platanus Aquehongensis Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 32, pl. 4.

This species was based upon a single specimen, the original figure of which is here reproduced. It is well defined and is totally unlike any other from this region. The reference to the genus *Platanus* was questioned by Dr. Lester F. Ward,[c] who, however, recognized its validity as a new species, possibly belonging to *Vitis* or *Grewiopsis*.

Locality: Richmond Valley, Staten Island. Collected by Mr. Mesner. Specimen in Mus. Staten Island Assn. Arts and Sci.

Platanus? Newberryana Heer.

Platanus? Newberryana Heer, Nouv. Mem. Soc. Helv. Sci. Nat., vol. 22, No. 1 (Phyll. Crét. Nebr.), 1867, p. 16, pl. 1, fig. 4; Pollard, Trans. New York Acad. Sci., vol. 13, 1894, p. 181.

This species is listed by Pollard (loc. cit.) as occurring at Elm Point, Great Neck, Long Island, but the specimen was not seen by me.

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[a] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), pl. 32, fig. 14.
[b] Ibid., p. 87, pl. 17, figs. 1, 12.
[c] Am. Jour. Sci., vol. 45, 1893, p. 437.

Platanus sp.

Pl. XXXI, fig. 5.

Platanus Newberryana Heer, Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 103, pl. 4, fig. 9.

The original unquestioned reference of this specimen by me to *P. Newberryana* Heer was manifestly not warranted by its fragmentary character, although there can be but little doubt that it represents a portion of a *Platanus* leaf.

Locality: Princess Bay, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Family ROSACEÆ.

Subfamily POMACEÆ.

Amelanchier Whitei n. sp.

Pl. XXXII, fig. 1.

Leaf 6 centimeters long by 2.5 centimeters wide in the middle, elliptical-lanceolate in outline, tapering above, rounded to the base, short petioled, finely and uniformly serrate-dentate almost to the base; secondary nerves curving upward from the midrib at acute angles; tertiary nervation fine, subparallel, almost horizontal or slightly curved downward.

This leaf apparently belongs to *Amelanchier* or some closely allied genus, and the indications are that it had a somewhat abruptly attenuated or tapering apex. There does not seem to be any described Cretaceous species with which it may be identified, but it is closely similar to *A. typica* Lesq., from the Tertiary of Florissant, Colo.[a] Named for Mr. David White, the collector.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Family LEGUMINOSÆ.

Subfamily CÆSALPINIACEÆ.

Hymenæa dakotana Lesquereux.

Pl. XXXII, figs. 5–7.

Hymenæa dakotana Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 145, pl. 55, figs. 2, 3; pl. 56, figs. 1, 2; pl. 62, fig. 2; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 56, pl. 176, fig. 4.
Dalbergia Rinkiana Heer, Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 236, pl. 6, fig. 5.

The distinction between this species and *Dalbergia Rinkiana* Heer[b] is hardly discernible, but Lesquereux's figures are much better defined, and comparison with these is therefore more satisfactory. Our fig. 5 is practically identical with Lesquereux's fig. 2, pl. 56, and our fig. 6 may be compared with his fig. 3, pl. 55.

Locality: Sea Cliff, Long Island, Pl. XXXII, fig. 5. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Lloyd Neck, Long Island, Pl. XXXII, fig. 6. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XXXII, fig. 7. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Cret. and Tert. Fl., 1883, p. 198, pl. 40, fig. 11.
[b] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 102, pl. 26, figs. 1–3.

Hymenæa primigenia Saporta.

Pl. XXXII, figs. 8, 9.

Hymenæa primigenia Sap., Monde des Plantes, 1879, p. 199, fig. 2; Velenòvsky, Fl. Böhm. Kreideform., pt. 3, 1884, p. 9 (56), pl. 5 (20), fig. 4; pl. 6 (21), figs. 1–4.

These specimens are apparently narrow forms of the leaves which Velenovsky refers to this species. Saporta's original figure (loc. cit.) shows leaves with entire margins, but in many of those figured by Velenovsky (loc. cit.) the margins are crenate dentate, as in ours. In fact, he makes this one of the characters of the species and says, "seldom entire margined."

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Cassia sp.

Pl. XXXII, fig. 13.

This specimen may possibly be the base of a leaf of *Cassia angusta* Heer,[a] which is considered by him to be identical with *Palæocassia angustifolia* Etts.,[b] a name not admissible by reason of the previously published *Cassia angustifolia* Vahl, a living species.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Subfamily PAPILIONACEÆ.

Colutea primordialis Heer.

Pl. XXXII, figs. 14, 15.

Colutea primordialis Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 99, pl. 27, figs. 7–11; pl. 43, figs. 7, 8; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 56, pl. 174, fig. 2.

A great variety of forms is included in this species by Heer, and their close similarity to some of the varieties of *Liriodendropsis*[c] will doubtless be noted, but as a whole their obovate or elliptical shape serves to distinguish them. Newberry refers two specimens from the Cretaceous of New Jersey to the same species,[d] but the reference hardly appears to be warranted by the figures.

The leaf described and figured by Lesquereux under the name *Liriophyllum obcordatum*[e] may perhaps be a form of this species and would probably be so considered in any critical revision of the leaves with obcordate or obovate-emarginate outlines.

Locality: Eatons Neck, Long Island, Pl. XXXII, fig. 14. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XXXII, fig. 15. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 101, pl. 27, fig. 6.

[b] Sitzb. Wien-Akad. Wissensch., Math.-Naturw. Cl., vol. 55 (abth. 1), (Kreidefl. Niederschöna), 1867, p. 261, pl. 3, figs. 6, 7.

[c] See this monograph, Pls. XXIV, XXV, XXVI.

[d] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 97, pl. 19, figs. 4, 5.

[e] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 210, pl. 28, fig. 7.

Dalbergia hyperborea Heer.?

Pl. XXXII, fig. 10.

Dalbergia hyperborea Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 102, pl. 26, fig. 4a; Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 103, pl. 4, fig. 7.

The identity of this specimen is probably with either *D. hyperborea* Heer (loc. cit.) or *D. Rinkiana* Heer,[a] the close resemblance between which was recognized by Heer. He emphasizes, however, the rounded cordate base of the former as a distinguishing feature, and this is quite well defined in our specimen.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Dalbergia minor n. sp.

Pl. XXXII, fig. 12.

Leaf small, entire, about 1.3 centimeters long, slightly inequilateral and curved, about 6 millimeters wide at the abruptly rounded base, tapering to the apex; nervation obscure.

This is not a very satisfactory specimen upon which to base a description of a new species, but I have been unable to identify it with any heretofore recognized Cretaceous form. In general appearance it is suggestive of the genus *Dalbergia*.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Dalbergia irregularis n. sp.

Pl. XXXII, fig. 11.

Leaf about 3.8 centimeters long by 1.8 centimeters wide in the middle, entire, inequilateral, curved, tapering to an acute apex, rounded at the base on the narrower side, cuneate on the broader side; nervation reticulate, leaving the convex side of the midrib at acute angles and the concave side at right angles.

The fossil species which most nearly resembles our specimen is *Leguminosites dalbergioides* Etts.,[b] from the Tertiary of Europe.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Phaseolites elegans n. sp.

Pl. XXXII, fig. 4.

Dalbergia Rinkiana Heer. Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 236, pl. 6, fig. 4.

Leaf inequilateral, entire, ovate-falcate in outline, tapering to a curved apex, narrowed to an acute wedge-shaped base, short petioled; secondary nerves few or obscure, those on the broader side forming angles with the midrib more acute than those on the narrower side, all curving upward.

This leaf has some of the characteristics of *Dalbergia Rinkiana* Heer[c] and certain of the forms figured under *Phaseolites formus* Lesq.[d] It also bears a more or less close resemblance to our fig. 5, pl. XXXII, which I have referred to *Hymenæa dakotana* Lesq. Its almost perfect ovate-falcate outline, however, serves to distinguish it from any of the published figures of these species.

Locality: Brooklyn, Long Island. Specimen in Mus. New York Bot. Gard.

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[a] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 102, pl. 26, figs. 1–3.
[b] Abh. K.-K. Geol. Reichsanst., vol. 2 (abth. 3, No. 2, Tert. Fl. Häring), 1855, p. 91, pl. 30, figs. 18–20.
[c] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 102, pl. 26, figs. 1–3.
[d] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 147, pl. 55, figs. 5, 6, 12.

Phaseolites manhassettensis Hollick.

Pl. XXXII, figs. 2, 3.

Phaseolites Manhassettensis Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 414, pl. 78, figs. 1, 2.

The distinction between this species and the one last described consists mainly in the more acute angle of divergence between the secondaries and the midrib in the species now under consideration, although it may be seen that there are also slight differences in outline.

Locality: Manhassett Neck, Long Island. Collected by A. E. Anderson. Specimens in Mus. New York Bot. Gard.

LEGUMINOSÆ OF UNCERTAIN RELATION.

Leguminosites coronilloides Heer.

Pl. XXXII, figs. 16, 17.

Leguminosites coronilloides Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 119, pl. 34, fig. 14; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 97, pl. 42, fig. 48.
Leguminosites frigidus Heer. Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 34, pl. 2, fig. 11.

There is but little choice between the above species as figured by Heer, especially between his figure of *L. coronilloides* (loc. cit.) and the specimen of *L. frigidus* represented by his fig. 22, pl. 55.[a]

Locality: Kreischerville, Staten Island, Pl. XXXII, fig. 16. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Gay Head, Marthas Vineyard, Pl. XXXII, fig. 17. Collected by David White. Specimen in U. S. Nat. Mus.

Leguminosites constrictus Lesquereux?

Pl. XXXII, fig. 20.

Leguminosites constrictus Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 151, pl. 44, fig. 3; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 56, pl. 177, fig. 13.

The identification of this specimen must be regarded as purely tentative on account of the missing upper portion.

Locality: Oak Neck, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Leguminosites convolutus Lesquereux?

Pl. XXXII, figs. 18, 19.

Leguminosites convolutus Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 151, pl. 44, fig. 4; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 56, pl. 177, fig. 14, Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50.

The identification of these specimens is questioned, for the reason that neither one is complete, although each one shows certain characters which appear to be similar to those of the species. As in the case of the species last described, however, better material is required for satisfactory identification.

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[a] Fl. Foss. Arct., vol. 7.

Locality: Glen Cove, Long Island, Pl. XXXII, fig. 18. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XXXII, fig. 19. Collected by David White. Specimen in U. S. Nat. Mus.

Order SAPINDALES.

Family ANACARDIACEÆ.

Rhus cretacea Heer?

Pl. XXXIII, fig. 2.

Rhus cretacea Heer, Kreide-Fl. Quedlinburg, 1872, p. 14, pl. 3, fig. 11.

This specimen, although more robust, is so closely similar to this species that at least a provisional reference seems warranted. In general appearance it is perhaps more like the Tertiary species *Rhus Pyrrhæ* Ung.,[a] especially as depicted by Heer.[b] It also has some resemblance to the imperfect leaf described and figured by Lesquereux under the name *Ficus? undulata.*[c]

Locality: Glen Cove, Long Island. Collected by David White. Specimen in U. S. Nat. Mus.

Pistacia aquehongensis Hollick.

Pl. XXXIII, fig. 3.

Pistacia Aquehongensis Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 421, pl. 36, fig. 5.

The type specimen, the figure of which is here reproduced, is all that we have to represent the species, and it is the only representative of the genus thus far found in our region. It is closely similar to *P. aquensis* Sap.,[d] which, however, is a European Tertiary species. If the generic reference is correct, as it appears to be, the specimen is of considerable interest, as the only other supposed North American fossil representatives of the genus are the specimens described by Lesquereux under the name *Ficus oblanceolata,* from the Laramie group,[e] which Knowlton subsequently relegated to *Pistacia.*[f]

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Family ILICACEÆ.

Ilex papillosa Lesquereux.

Pl. XXXIII, fig. 4.

Ilex papillosa Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 177, pl. 29, figs. 9, 10; pl. 58, fig. 3.

This is one of the few specimens contained in a small lot described in a memorandum by Dr. Lester F. Ward, as follows: "562. Clays, buff and more or less carbonaceous, from south shore of Gay Head. They came from the steep strata in the

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a Chl. Protog., 1843, p. 84, pl. 22, fig. 1.
b Fl. Tert. Helvet., 1859, vol. 3, pl. 126, figs. 20–28.
c Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 84, pl. 12, fig. 5.
d Annals sci. nat., 4th series, Bot., vol. 18, 1873, p. 105, pl. 15, figs. 1–24.
e Tert. Fl., 1878, p. 194, pl. 28, figs. 9–12.
f Bull. U. S. Geol. Survey No. 152 (Cat. Cret. and Tert. Plants N. Am.), 1898, p. 167.

buttress a little to the east of the flow and plunge structure (Weyquosque), and are regarded as post-Tertiary by Professor Shaler."

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Family CELASTRACEÆ.

Celastrus arctica Heer.

Pl. XXXIII, figs. 9–11.

Celastrus arctica Heer, Fl. Foss. Arct., vol. 7, 1883, p. 40, pl. 61, figs. 5d, 5e; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 98, pl. 13, figs. 8–18; Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 60, pl. 4, fig. 8; Bull. New York Bot. Gard., vol. 3, 1904, p. 408, pl. 70, figs. 12, 13.

These specimens, although fragmentary, show the characteristic shape and nervation of the species quite satisfactorily. It is one of the most abundant species in the Amboy clays, and some of the numerous diverse forms depicted by Newberry (loc. cit.) are exactly like ours, all of which are considerably larger than the single specimen figured by Heer from the Patoot beds of Greenland (loc. cit.).

Locality: Little Neck (Northport Harbor), Long Island, Pl. XXXIII, figs. 9, 10. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Black Rock Point, Block Island, Pl. XXXIII, fig. 11. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Celastrophyllum grandifolium Newberry?

Pl. XXXIII, fig. 8.

Celastrophyllum grandifolium Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 104, pl. 19, fig. 8; pl. 21, figs. 1–4.

This specimen appears to be the lower part of a very large leaf of this species, or possibly of *Celastrophyllum ensifolium* (Lesq.),[a] but its imperfect condition renders satisfactory comparison impossible. Newberry also refers to this species and calls attention to the resemblance between *C. grandifolium* and *C. lanceolatum* Etts.,[b] and says (loc. cit.): "With more material we may find that the species should be united."

Locality: Nashaquitsa, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Gyminda primordialis, n. sp.

Pl. XXXIII, fig. 5.

Leaf linear-obovate-spatulate, obscurely crenate above, entire below; nervation consisting of five pairs of opposite, almost straight secondaries, which form acute angles with the midrib and ultimately coalesce into an irregular submarginal nerve.

This well-defined leaf is clearly different from any species hitherto described. Its affinities are apparently with the Celastraceæ, and it may be compared with many

[a] Cret. Fl., 1874, p. 108, pl. 21, figs. 2, 3 (=*Magnolia ensifolia* Lesq., U. S. Geol. and Geog. Survey Terr., 1871 (1872), p. 302.)

[b] Sitzb. Akad. Wissensch. Wien, Math.-Naturwiss. Cl., vol. 55 (abth. 1), (Kreidefl. Niederschöna), 1867, p. 260, pl. 3, fig. 9.

of the leaves in the genera *Gyminda*, *Pterocelastrus*, and *Maytenus*, although in most of these the secondary nerves are only occasionally opposite.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

ELÆODENDRON STRICTUM, n. sp.

Pl. XXXIII, fig. 6.

Leaf linear-ovate-lanceolate in outline, crenate-dentate above, entire below, tapering to a slightly rounded wedge-shaped base; secondary nerves in pairs, almost straight, forming acute angles with the midrib, extending upward and giving off nervilles from their outer sides which extend to the marginal dentitions.

This leaf is characterized by the almost straight secondary nerves, arranged in pairs, thus differing from any other described species.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

ELÆODENDRON sp.

Pl. XXXIII, fig. 7.

Celastrophyllum Benedini Sap. et Mar., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 58, pl. 177, fig. 4.

This specimen probably represents a new species, but it is too imperfect to serve as a basis for satisfactory description. It is somewhat suggestive of *Elæodendron speciosum* Lesq.,[a] but the dentition is much finer.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Family ACERACEÆ.

ACER MINUTUM Hollick.

Pl. XXXIII, fig. 14.

Acer minutus Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 35, pl. 3, fig. 6.

This is the only leaf which could be referred to a maple thus far found in the insular flora, and the figure is a reproduction of the figure of the type specimen. Winged seeds which apparently belong to the genus occur at Gay Head and in the Amboy clays of New Jersey, however, and it is possible that these may have come from the same species of tree as the leaf, but thus far we have not found them associated together.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

FRUIT OF ACER sp.

Pl. XXXIII, figs. 12, 13.

These winged seeds are very much like those which Newberry calls *Acer amboyense*,[b] from the Cretaceous of New Jersey, and they probably belong to the same

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 175, pl. 36, figs. 2, 3.
[b] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1875 (1896), p. 106, pl. 46, figs. 5–8.

species, but no leaves of the genus have been found associated with them either there or on Marthas Vineyard, where our specimens were found.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Family SAPINDACEÆ.

SAPINDUS IMPERFECTUS Hollick.

Pl. XXXIII, fig. 15.

Sapindus imperfectus Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 415, pl. 78, fig. 4.

This species is very closely allied to *S. morrisoni* Lesq.,[a] and may perhaps be regarded merely as a form of that species.

Locality: Manhassett Neck, Long Island. Collected by A. E. Anderson. Specimen in Mus. New York Bot. Gard.

SAPINDUS MORRISONI Lesquereux.

Pl. XXXIII, figs. 16–20.

Sapindus Morrisoni Lesq., Cret. and Tert. Fl., 1883, p. 83, pl. 16, figs. 1, 2; White, Am. Jour. Sci., vol. 39, 1890, p. 99, pl. 2, fig. 12; Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 103, pl. 3, fig. 5; ibid., vol. 12, 1893, p. 235, pl. 6, fig. 3; Bull. Torrey Bot. Club, vol. 21, 1894, p. 57, pl. 179, fig. 8; Bull. Geol. Soc. Am., vol. 7 1895, p. 13; Annals New York Acad. Sci., vol. 11, 1898, p. 422, pl. 36, fig. 4; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 83, pl. 47, figs. 2, 3; Bull. Torrey Bot. Club, vol. 31, 1904, p. 78.

The great variety of shape and size in this species is well represented in our specimens. Figs. 18 and 19 are about the average in size and are most nearly like Lesquereux's type figures (loc. cit.); fig. 19 is like his specimens subsequently figured;[b] fig. 16 is somewhat broader than any other specimen which I have seen depicted, but it hardly differs to a sufficient extent to be regarded as a new species, and fig. 17 may be satisfactorily compared with some of the forms figured by Heer from the Cretaceous of Greenland,[c] especially with his fig. 8 (loc. cit.), in which the finer nervation is suggestive of some other genus, as it is in our fig. 17. In fact, if it were not for the characteristic unsymmetrical base in our specimen—rounded on one side and cuneate on the other—I should probably have considered it under some other generic name.

Locality: Glen Cove, Long Island, Pl. XXXIII, figs. 16–18. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Princess Bay, Staten Island, Pl. XXXIII, fig. 19. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Tottenville, Staten Island, Pl. XXXIII, fig. 20. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

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[a] Cret. and Tert. Fl., 1883, p. 83, pl. 16, figs. 1, 2.
[b] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, pl. 35, figs. 1, 2.
[c] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, pl. 43, fig. 1a; pl. 44, fig. 8.

Sapindus apiculatus Velenovsky.

Pl. XXXIII, fig. 21.

Sapindus apiculatus Vel., Fl. Böhm. Kreideform., pt. 3, 1884, p. 6 (53), pl. 7 (22), figs. 1–8; Hollick, Trans. New York Acad. Sci., vol. 16, 1897, p. 133, pl. 13, figs. 1, 2.

I am unable to recognize any valid difference between this species and *Sapindus diversifolius* Lesq.,[a] although the latter author regarded them as distinct species, but "closely allied" (loc. cit. p. 159).

Locality: Glen Cove, Long Island. Collected by David White. Specimen in U. S. Nat. Mus.

Order RHAMNALES.

Family RHAMNACEÆ.

Paliurus integrifolius Hollick.

Pl. XXXIV, figs. 2–5.

Paliurus integrifolius Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 57, pl. 177, figs. 5, 8, 12; Trans. New York Acad. Sci., vol. 16, 1897, p. 133, pl. 14, fig. 10; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r50; Bull. New York Bot. Gard., vol. 3, 1904, p. 408, pl. 70, fig. 7; Ries, Sch. Mines Quart., vol. 15, 1894, p. 353.

Fragmentary remains of these leaves, showing considerable diversity in size, are relatively abundant in the insular flora, especially on Long Island, but they have not been satisfactorily identified elsewhere. It is unfortunate that in no instance has a perfect specimen been found, and the characters of the upper part of the leaves are not known.

Locality: Oak Neck, Long Island, Pl. XXXIV, fig. 2. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Lloyd Neck, Long Island, Pl. XXXIV, fig. 3. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Glen Cove, Long Island, Pl. XXXIV, fig. 4. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Little Neck (Northport Harbor), Long Island, Pl. XXXIV, fig. 5. Collected by Heinrich Ries. Specimen in Mus. New York Bot. Gard.

Paliurus ovalis Dawson.

Pl. XXXIV, fig. 14.

Paliurus ovalis Dawson, Trans. Roy. Soc. Canada, sec. 4 (Mesoz. Fl. Rocky Mt. Region), 1885, p. 14, pl. 4, figs. 4, 8; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 107, pl. 23, figs. 8, 9.

This specimen, so far as the characters of the nervation are concerned, shows considerably more than Dawson's type figures (loc. cit.), or than can be seen in Lesquereux's figure of a specimen from Kansas.[b] The shape of the leaf, however,

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 158, pl. 64, fig. 18.
[b] Ibid., pl. 35, fig. 7.

is identical in all, and our specimen appears to more satisfactorily represent the species than do the two specimens from the Amboy clays (loc. cit.) so referred by Newberry, the identity of which is open to question.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Paliurus affinis Heer.?

Pl. XXXIV, figs. 6, 7.

Paliurus affinis Heer, Fl. Foss. Arct., vol. 7, 1883, p. 42, pl. 62, figs. 16–19; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 35, pl. 2, figs. 12, 14, 18; pl. 3, fig. 7.

It is quite possible that these specimens may belong with *Paliurus cretaceus* Lesq.,[a] which is so closely similar in appearance to *P. affinis* Heer, as to be hardly distinguishable from it, but they are too fragmentary for satisfactory comparison.

Locality: Tottenville, Staten Island, Pl. XXXIV, fig. 6. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Kreischerville, Staten Island, Pl. XXXIV, fig. 7. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Zizyphus elegans Hollick.

Pl. XXXIV, fig. 8.

Zizyphus elegans Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 58, pl. 177, fig. 9.

This beautiful little species is represented in our collections from Glen Cove by a number of fragments as well as by the perfect type specimen, the figure of which is here reproduced. It occurs with and is evidently closely related to the species next described.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Zizyphus oblongus n. sp.

Pl. XXXIV, figs. 9, 10.

Zizyphus elegans Hollick in part, Bull. Torrey Bot. Club, vol. 21, 1894, p. 58, pl. 177, fig. 10; Bull. New York Bot. Gard., vol. 3, 1904, p. 415, pl. 73, fig. 4.

Leaves oblong, entire, 3-nerved from the base; lateral primaries rather sharply curved below, soon extending upward subparallel with the midrib, giving off branches on the outside, the latter forming acute angles with the lateral primaries, and curving upward toward the margins; midrib and lateral primaries connected by an irregularly disposed system of fine cross nervation.

This species was originally included by me in *Zizyphus elegans* (loc. cit.), but this was due to the imperfect specimen, the illustration of which is reproduced in fig. 9. New material since obtained indicates that a distinct species should be recognized, characterized by an oblong instead of ovate form of leaf. Thus far I have not succeeded in finding any specimen which shows the upper part, so that it is impossible to determine whether the oblong character of the lower part prevails throughout.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

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[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 165, pl. 35, fig. 3.

Zizyphus grönlandicus Heer.

Pl. XXXIV, figs. 11, 12.

Zizyphus grönlandicus Heer, Fl. Foss. Arct., vol. 7, 1883, p. 42, pl. 62, fig. 20.

In spite of the paucity of our material and the imperfect condition of the two specimens, I have but little hesitation in regarding them as belonging to this species.

Locality: Nashaquitsa, Marthas Vineyard, Pl. XXXIV, fig. 11. Collected by David White. Specimen in U. S. Nat. Mus.

Gay Head, Marthas Vineyard, Pl. XXXIV, fig. 12. Collected by David White. Specimen in U. S. Nat. Mus.

Zizyphus Lewisiana Hollick.

Pl. XXXIV, fig. 13.

Zizyphus Lewisiana Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 58, pl. 180, fig. 13.

The only specimen of this species thus far known is the type, the original figure of which is here reproduced.

Locality: Oak Neck, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Rhamnus (?) acuta Heer.

Pl. XXXIV, fig. 1.

Rhamnus (?) *acuta* Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 98, pl. 41, fig. 6; pl. 45, fig. 13c; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 58, pl. 177, fig. 6.

This specimen is apparently referable either to this species or to *R. tenax* Lesq.,[a] and in placing it under Heer's name I should be considered as influenced more by considerations of priority than by any intention to indicate that the two species are distinct.

Locality: Lloyd Neck, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Ceanothus constrictus n. sp.

Pl. XXXIV, figs. 15–17.

Leaves obovate-spatulate in outline, entire, obscurely 2-lobed or constricted above, with a retuse, emarginate, or truncate apex and a wedge-shaped base; secondary nerves irregularly arranged, the lower ones leaving the midrib at or close to the base, extending upward subparallel with the margins and finally anastomosing with the upper ones, forming a series of marginal loops.

These leaves apparently belong in the Rhamnaceæ and are not unlike those of the living species *Ceanothus cuneatus* Nutt. They do not, however, appear to be strictly 3-nerved from the base, although the lower secondaries simulate lateral primaries very closely. The only fossil leaf which appears at all to resemble them is *Ceanothus bilinicus* Ung.,[b] a European Tertiary species.

Locality: Gay Head, Marthas Vineyard, Pl. XXXIV, figs. 15, 16. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXXIV, fig. 17. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 170, pl. 38, fig. 6.
[b] Chl. Prot., 1847, p. 145, pl. 49, fig. 9.

Family VITACEÆ.

Cissites formosus Heer?

Pl. XXXVII, fig. 7.

Cissites formosus Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 85, pl. 21, figs. 5–8; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 57, pl. 174, fig. 6; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 107, pl. 47, figs. 1–8.

This very unsatisfactory specimen is referred to this species with considerable hesitation and the identification must be regarded as merely provisional.

Locality: Dosoris Island, Long Island. Collected by Bailey Willis. Specimen in Mus. New York Bot. Gard.

Order MALVALES.

Family STERCULIACEÆ.

Sterculia pre-labrusca n. sp.

Pl. XXXIV, figs. 21, 22.

Sterculia labrusca Ung. Hollick, Bull. Geol. Soc. Am., vol. 7, p. 13.

Leaf narrowly lobed, entire; lobes more or less flexuous or irregular in shape; secondary nervation fine, often branched, irregularly disposed, leaving the primary nerves at varying angles of divergence and extending to the margins.

The decision to found a new species upon these fragmentary remains may be open to criticism, but I can not avoid the conviction that they should be so regarded and that they represent a species allied to *Sterculia labrusca* Ung.,[a] from the Tertiary of Europe. Subsequent figures by Ettingshausen[b] approach ours even more closely in general appearance and indicate a close relationship.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Sterculia Snowii Lesquereux?

Pl. XXXIV, fig. 20.

Sterculia Snowii Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 183, pl. 30, fig. 5; pl. 31, figs. 2, 3; pl. 32; pl. 33, figs. 1–4.

I have referred this fragment to the above species provisionally, although it is possible that even the generic reference may be erroneous. It is evidently a portion of a lobed leaf which might perhaps belong to either a *Sterculia*, an *Aralia*, or a *Sassafras*.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Foss. Fl. Sotzka, 1850, p. 45 [175], pl. 28 [49], figs. 1–11.
[b] Foss. Fl. Bilin, 1869, pl. 43, figs. 4, 5.

Sterculia sp.

Pl. XXXIV, figs. 18, 19.

Sterculia sp.? Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 422, pl. 37, fig. 5.

These fragments apparently represent lobes of some narrow-leaved *Sterculia*, similar to *S. lugubris* Lesq.[a]

Locality: Gay Head, Marthas Vineyard, Pl. XXXIV, fig. 18. Collected by David White. Specimen in U. S. Nat. Mus.

Tottenville, Staten Island, Pl. XXXIV, fig. 19. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Pterospermites modestus Lesquereux.

Pl. XXXVIII, fig. 8.

Pterospermites modestus Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 186, pl. 58, fig. 5; Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 422, pl. 37, fig. 6.

There can hardly be any question that our specimen is identical with this species as described and figured by Lesquereux from the Dakota group, but it may also be compared with *Apeibopsis thomseniana* Heer[b] from the lower Atane beds of Greenland, and the question whether or not these two species should be regarded as distinct is largely one of personal choice.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Order MYRTALES.

Family MYRTACEÆ.

Eucalyptus? nervosa Newberry.

Pl. VIII, fig. 6b; Pl. XXXV, fig. 16.

Eucalyptus? nervosa Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 112, pl. 32, figs. 3–5, 8; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 56, pl. 174, fig. 10.

These fragments are manifestly not satisfactory subjects for identification, but they represent portions of linear leaves apparently identical with Newberry's species, as may be seen by comparison with his figures (loc. cit.).

Locality: Black Rock Point, Block Island, Pl. VIII, fig. 6b. Collected by Arthur Hollick.

Sea Cliff, Long Island, Pl. XXXV, fig. 16. Collected by Gilbert Van Ingen. Specimen in Mus. New York Bot. Gard.

Eucalyptus? angustifolia Newberry.

Pl. XXXV, figs. 9, 14, 15.

Eucalyptus? angustifolia Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 111, pl. 32, figs. 1, 6, 7; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 408, pl. 70, figs. 8, 9.
Eucalyptus Geinitzi Heer [?]. Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 87, pl. 53, fig. 3.

In grouping these figures of apparently widely different forms under the one specific name I have followed Newberry in his treatment of the species (loc. cit.).

[a] Cret. and Tert. Fl., 1883, p. 81, pl. 6, figs. 1–3.
[b] Fl. Foss. Arct., vol. 6, (abth. 2), 1882, p. 95, pl. 26, fig. 5.

Our fig. 9, for example, is almost certainly identical with his fig. 1, while our figs. 14, 15 may be equally well compared with his figs. 6, 7, although there seems to be but little doubt that two different species are represented.

Locality: Gay Head, Marthas Vineyard, Pl. XXXV, fig. 9. Collected by David White. Specimen in U. S. Nat. Mus.

Little Neck (Northport Harbor), Long Island, Pl. XXXV, figs. 14, 15. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Eucalyptus Geinitzi (Heer) Heer.

Pl. XXXV, figs. 1–8, 10–12.

Eucalyptus Geinitzi (Heer), Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 93, pl. 19, fig. 1c; pl. 46, figs. 12e, 13; White, Am. Jour. Sci., vol 39, 1890, p. 98, pl. 2, fig. 8; Uhler, Trans. Maryland Acad. Sci., vol. 1, 1892 (1901), p. 207; Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 99, pl. 2, fig. 1; ibid., vol. 12, 1892, p. 34, pl. 2, fig. 5; Bull. Torrey Bot. Club, vol. 21, 1894, p. 55, pl. 177, fig. 11; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Annals New York Acad. Sci., vol. 11, 1898, p. 60, pl. 4, figs. 1–3; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 110, pl. 32, figs. 2, 12, 15 (16?).

Myrtophyllum (*Eucalyptus?*) *Geinitzi* Heer, Neue Denkschr. Schw. Gesellsch. Naturwissensch., vol. 23 (Fl. Moletein), 1869, p. 22, pl. 11, figs. 3, 4.

The variety of forms which Heer and subsequent authorities have referred to this species is probably as great as is to be found in any other fossil leaf species. The type figures from Moletein (loc. cit.) are unquestionably identical with our fig. 10, while between these and the larger, broader forms figured by Velenovsky[a] there is every possible gradation in size and shape, and it is impossible to resist the conviction that several distinct species should be recognized among them. Ours are fairly uniform, however, and present but minor differences between themselves, so that I have but little hesitation in regarding them as all belonging to one species.

Locality: Black Rock Point, Block Island, Pl. XXXV, figs. 1, 2. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

Southeast Point, Block Island, Pl. XXXV, fig. 11. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XXXV, figs. 3, 5–8. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXXV, fig. 4. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Tottenville, Staten Island, Pl. XXXV, fig. 10. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Eucalyptus Schübleri (Heer)? n. comb.

Pl. XXXVI, fig. 6.

Myrtophyllum (*Eucalyptus*) *Schübleri* Heer, Neue Denkschr. Schw. Gesellsch. Naturwissensch., vol. 23 (Fl. Moletein), 1869, p. 23, pl. 11, fig. 2.

It is unfortunate that in both our specimens and Heer's only a portion of each leaf is preserved, so that the identification can be regarded as only provisional. In ours the indicated shape of the leaf is somewhat more linear than in Heer's, but the reticulated network of secondary and tertiary nerves, which ultimately join and form the marginal nerve, is identical in both.

[a] Fl. Böhm. Kreideform., pt. 4, 1885, pl. 2 (25), figs. 1–5.

It is probable that the fragmentary leaf remains from the clay marl of Cliffwood, N. J., which Berry refers to *Ficus reticulata* (Lesq.) Knowlton,[a] belong with our species and not with that to which they are referred.

Locality: Nashaquitsa, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Eucalyptus latifolia n. sp.

Pl. XXXVI, figs. 1–5.

Leaves large, about 1.5 decimeters long by 5.3 centimeters maximum width, entire, broadest about the middle, tapering rather abruptly to an attenuated, curved or flexuous, pointed apex and narrowed to the base; secondary nervation fine, numerous, leaving the midrib at angles of about 45°, irregularly disposed, flexuous, terminating in a marginal nerve.

This is apparently a large species of *Eucalyptus*, although in many respects it is suggestive of certain species of *Ficus*, as, for example, *F. protogæa* Heer,[b] in which, however, the characters of the apex are not described or figured. The leaves from our region which I regard as belonging to the latter species are depicted on Pl. X, figs. 4–6, of this monograph under *F. atavina* Heer.

Locality: Glen Cove, Long Island, Pl. XXXVI, fig. 1. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XXXVI, figs. 2–5. Collected by David White. Specimens in U. S. Nat. Mus.

Myrtophyllum Warderi Lesquereux.

Pl. XXXV, fig. 13.

Myrtophyllum Warderi Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 136, pl. 53, fig. 10.
Myrtophyllum (*Eucalyptus*?) *Geinitzi* Heer, Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 236, pl. 6, fig. 2.

It is unfortunate that both our figure and that of the type (loc. cit.) show only the lower parts of the leaves, but as far as these can be compared they are so closely alike that they might almost be taken for counterparts of the same specimen, and their specific identity is beyond question.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York. Bot. Gard.

Order UMBELLALES.

Family ARALIACEÆ.

Hedera simplex n. sp.

Pl. XXXVII, fig. 9.

Leaf palmately 3-lobed; lateral lobes broad, divergent, rounded below to a cordate base; secondary nerves rather remote from each other, diverging from the primaries at varying angles, ultimately bending sharply, joining, and forming a coarse network of subrectangular and polygonal areolæ.

This fragmentary specimen apparently indicates a leaf closely resembling our living ivy (*Hedera helix* L.).

Locality: Nashaquitsa, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Bull. New York Bot. Gard., vol. 3, 1903, p. 73, pl. 52, fig. 5; pl. 53, figs. 1, 4.
[b] Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 108, pl. 29, fig. 2b; pl. 30, figs. 1, 2a, 3, 3b, 4a, 8.

Aralia patens Newberry?

Pl. XXXVIII, fig. 3.

Aralia patens Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 117, pl. 28, fig. 3. Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 54, pl. 174, fig. 4.

In the Flora of the Amboy Clays (loc. cit.) Newberry describes and figures a broadly divergent type of *Aralia* under this name, with which our fragment may be provisionally identified.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Aralia palmata Newberry.

Pl. XXXVIII, fig. 4.

Aralia palmata Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 117, pl. 39, figs. 6, 7; pl. 40, fig. 3; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 93, pl. 44; Bull. Torrey Bot. Club, vol. 31, 1904, p. 79, pl. 4, fig. 12.

Aralia rotundiloba Newb.?, Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 421, pl. 38, fig. 2.

Aralia sp. Hollick, Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. 150.

This specimen was originally referred by me provisionally to *Aralia rotundiloba* Newb. (loc. cit.), but I am now convinced that it belongs to *A. palmata* Newb., and that it is identical with his fig. 3, pl. 40 (loc. cit.), which represents a specimen from the Amboy clays of New Jersey. Specimens apparently referable to the species have also been found in the clay marls at Cliffwood, N. J.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Aralia grönlandica Heer.

Pl. XXXVII, figs. 3–6.

Aralia grönlandica Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 84, pl. 38, fig. 3; pl. 39, fig. 1; pl. 46, figs. 16, 17; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 116, pl. 28, fig. 4; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 94, pl. 45, fig. 4.

The specimens represented by our figs. 4, 5 are apparently small 3-lobed forms of the species, which is the prevailing form in this region, agreeing with those figured by Newberry and Berry from the Cretaceous of New Jersey (loc. cit.). Fig. 6 is probably a portion of a lateral lobe with a small sublobe such as frequently occurs in the leaves of this species, especially in those so referred by Lesquereux from the Dakota group.[a] In many respects our fig. 5 bears a striking resemblance to *Sterculia Krejcii* Vel.[b] and to *S. aperta* Lesq.[c], except that in the latter species the lobes are more divergent. The great difference in size between our figs. 4 and 5 might seem to preclude the probability of their specific identity, but this feature seems to obtain in other species from the region, notably in the case of *Aralia polymorpha* Newb.,[d] and

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 134, pl. 54, figs. 1–3.
[b] Fl. Böhm Kreideform., pt. 2, 1883, p. 22 (47), pl. 5 (13), fig. 1.
[c] Cret. and Tert. Fl., 1883, p. 82, pl. 10, figs. 2, 3.
[d] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), pl. 39, figs. 1–5.

largely for that reason I have concluded to regard these two specimens as forms of one species.

Locality: Nashaquitsa, Marthas Vineyard, Pl. XXXVII, figs. 3, 6. Collected by David White. Specimen in U. S. Nat. Mus.

Gay Head, Marthas Vineyard, Pl. XXXVII, figs. 4, 5. Collected by David White. Specimen in U. S. Nat. Mus.

Aralia Ravniana Heer.

Pl. XXXVII, figs. 1, 2.

Aralia Ravniana Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 84, pl. 38, figs. 1, 2; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 92, pl. 46, fig. 7; pl. 53, fig. 2; pl. 57, fig. 1[?].
Sterculia Snowii Lesq.? Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 422, pl. 37, fig. 4.

These are not very satisfactory specimens upon which to base definite conclusions, but they agree fairly well with this species and with similar fragmentary remains so referred by Berry from the clay marls of Cliffwood, N. J. (loc. cit.).

Locality: Gay Head, Marthas Vineyard, Pl. XXXVII, fig. 1. Collected by David White. Specimen in U. S. Nat. Mus.

Tottenville, Staten Island, Pl. XXXVII, fig. 2. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Aralia nassauensis Hollick.

Pl. XXXVIII, figs. 1, 2.

Aralia Nassauensis Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 55, pl. 174, figs. 3, 7.

This species, of which the type specimens are here figured, appears to be related to *A. Wellingtoniana* Lesq.,[a] but is much broader.

Locality: Brooklyn, Long Island; fig. 1 collected by W. Miles; fig. 2 collected by J. C. Brevoort. Specimens in Mus. Long Island Hist. Soc.

Aralia coriacea Velenovsky.

Pl. XXXVIII, figs. 5, 6.

Aralia coriacea Vel., Fl. Böhm. Kreideform., pt. 3, 1884, p. 11 (58), pl. 1 (16), figs. 1–9; pl. 2 (17), fig. 2; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Bull. New York Bot. Gard., vol. 3, 1904, p. 415, pl. 73, fig. 3.

This species appears to be quite well defined in our specimens, and fig. 5 resembles so closely the shorter forms depicted by Velenovsky (loc. cit.) that there seems to be every reason for regarding them as identical. Several other specimens, more fragmentary however than those figured, are included in the collections from Gay Head and Glen Cove, so that it may be regarded as a not uncommon element of our insular flora in those localities.

Locality: Glen Cove, Long Island, Pl. XXXVIII, fig. 5. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XXXVIII, fig. 6. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 131, pl. 21, fig. 1; pl. 22, figs. 2, 3; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), pl. 26, fig. 1.

Panax cretacea Heer.

Pl. XXXVIII, fig. 7.

Panax cretacea Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 114, pl. 32, figs. 9, 9b, 9c, 9d, 10.

This little fruit has every appearance of identity with Heer's species and it is interesting to find it associated both in Greenland and in our region with leaves of araliaceous plants.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Chondrophyllum orbiculatum Heer.

Pl. XXXVII, fig. 8a.

Chondrophyllum orbiculatum Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.) 1874, p. 115, pl. 31, fig. 3c; pl. 32, fig. 13; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 35, pl. 2, fig. 2b.

Although the finer nervation is not preserved in our specimen the coarser nervation and the indicated form of the leaf are apparently identical with Heer's species.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Series II. GAMOPETALÆ.

Order ERICALES.

Family ERICACEÆ.

Kalmia Brittoniana Hollick.

Pl. XXXIX, figs. 8, 9.

Kalmia Brittoniana Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 34, pl. 2, figs. 7, 8.

The type specimens of this species, here figured, do not show any indications of secondary nervation, otherwise they might be compared with *Celastrophyllum cretaceum* Lesq.[a] from the Dakota group, and no others have yet been found. The absence of secondary nervation, indicating a leaf of thick, coriaceous texture was what largely influenced me in referring the leaves to the genus *Kalmia*.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Andromeda latifolia Newberry.

Pl. XXXIX, fig. 1.

Andromeda latifolia Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 120, pl. 33, figs. 6–10; pl. 34, figs. 6–11; pl. 36, fig. 10; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 416, pl. 79, fig. 3.

Among the numerous figures of this species given by Newberry (loc. cit.) the one which appears to denote unquestionable identity with our specimen is fig. 8, pl.

[a] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 173, pl. 38, figs. 12–14.

33. It evidently possessed considerable diversity of form and in some instances these can hardly be distinguished from certain forms of *A. Parlatorii* Heer, next described.

Locality: Oak Neck, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Andromeda Parlatorii Heer.

Pl. XXXIX, figs. 2–5.

Andromeda Parlatorii Heer, Nouv. Mem. Soc. Helvet. Sci. Nat., vol. 22, no. 1 (Phyl. Crét. Nebr.), 1867, p. 18, pl. 1, fig. 5; White, Am. Jour. Sci., vol. 39, 1890, p. 97, pl. 2, fig. 4; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 120, pl. 31, figs. 1–7; pl. 33, figs. 1, 2, 4, 5; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 54, pl. 175, fig. 2; Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Annals New York Acad. Sci., vol. 11, 1898, p. 420, pl. 37, fig. 7; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 97, pl. 50, figs. 1–4; Bull. Torrey Bot. Club, vol. 31, 1904, p. 79, pl. 1, figs. 1, 2.

This species has been made to include so many diverse forms that there does not seem to be any excuse or explanation necessary for regarding the specimens here figured as all belonging to it. The leaves depicted by Heer,[a] from Greenland are smaller than the majority of those from the Amboy clays of New Jersey (loc. cit.) and those from the Dakota group of the West,[b] with which latter our fig. 2 may be compared, while our other figures are almost exactly duplicated by certain of the smaller forms from Greenland and New Jersey.

Locality: Nashaquitsa, Marthas Vineyard, Pl. XXXIX, fig. 2. Collected by David White. Specimen in U. S. Nat. Mus.

Gay Head, Marthas Vineyard, Pl. XXXIX, fig. 3. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Tottenville, Staten Island, Pl. XXXIX, fig. 4. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Glen Cove, Long Island, Pl. XXXIX, fig. 5. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Andromeda flexuosa Newberry.

Pl. XXXIX, fig. 6.

Andromeda flexuosa Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 121, pl. 34, figs. 1–5; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 416, pl. 79, fig. 2.

The distinction between this species and certain forms of the one last described is often rather difficult to determine, but there seems to be no doubt that the specimen here figured is referable to *A. flexuosa* as differentiated by Newberry.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, pl. 32, figs. 1, 2; vol. 6 (abth. 2), 1880, pl. 21, figs. 1b, 1i; pl. 42, fig. 4c.

[b] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, pl. 19, fig 1; pl. 52, fig. 6.

Andromeda tenuinervis Lesquereux.

Pl. XXXIX, fig. 7.

Andromeda tenuinervis Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 116, pl. 38, fig. 7.
Rhamnus Pfaffiana Heer, Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 103, pl. 4, fig. 2.

The original determination of this specimen by me as *Rhamnus Pfaffiana* Heer was undoubtedly erroneous, and there can be but little doubt that its present reference is correct, and unquestionably the leaf is more like *Andromeda* than are many to which that generic name has been applied.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Order PRIMULALES.

Family MYRSINACEÆ.

Myrsine elongata Newberry.

Pl. VIII, fig. 1b; Pl. XXXIX, figs. 13, 14.

Myrsine elongata Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 122, pl. 22, figs. 1–3; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 54, pl. 177, fig. 2; Annals New York Acad. Sci., vol. 11, 1898, p. 420, pl. 38, figs. 3, 4b.

The specimen represented by our fig. 13 has a more elongated base than any of Newberry's figures, thus giving to the leaf a spatulate shape, but a very slight modification of the outline would be sufficient to make it conform to the general type, and I have but little hesitation in including it under this species.

Locality: Arrochar, Staten Island, Pl. VIII, fig. 1b; Pl. XXXIX, fig. 14. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Lloyd Neck, Long Island, Pl. XXXIX, fig. 13. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Myrsine borealis Heer.

Pl. XXXIX, figs. 10, 11.

Myrsine borealis Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 113, pl. 32, fig. 23; White, Am. Jour. Sci., vol. 39, 1890, p. 98, pl. 2, fig. 5; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 122, pl. 24, figs. 4–6 [?].
Diospyros rotundifolia Lesq., Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 53, pl. 179, fig. 2.

I consider it very doubtful if the leaves from the Cretaceous of New Jersey, referred by Newberry to this species (loc. cit.), should be so regarded, but there seems to be no room for doubt in regard to our specimens.

Locality: Gay Head, Marthas Vineyard, Pl. XXXIX, fig. 10. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XXXIX, fig. 11. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Myrsinites? Gaudini Lesquereux.

Pl. XXXIX, fig. 12.

Myrsinites? Gaudini Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 115, pl. 52, fig. 4.
Rhamnus Rossmässleri Ung., Hollick, Trans. New York Acad Sci., vol. 12, 1892, p. 35, pl. 3, fig.5.

The original identification of this specimen as *Rhamnus Rossmässleri* Ung., a Tertiary species, was undoubtedly erroneous, and it is certain that it is identical generically with leaves which have been referred to *Myrsine* or *Myrsinites* and apparently to this species.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Order EBENALES.

Family EBENACEÆ.

Diospyros primæva Heer.

Pl. XL, figs. 2, 11.

Diospyros primæva Heer, Nouv. Mem. Soc. Helv. Sci. Nat., vol. 22, no. 1 (Phyl. Crét. Nebr.), 1867, p. 19, pl. 1, figs. 6, 7; Pollard, Trans. New York Acad. Sci., vol. 13, 1894, p. 180; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 124, pl. 30, figs. 1–5; Berry, Bull. Torrey Bot. Club, vol. 32, 1905, p. 46, pl. 2, fig. 2.

A considerable number of diverse forms have been included by Heer under this species,[a] in addition to which a number of others were subsequently referred to the species by Lesquereux[b] and Newberry (loc. cit.). For this reason I have also decided to include the doubtful fragmentary specimen represented by our fig. 11.

Locality: Gay Head, Marthas Vineyard, Pl. XL, fig. 2. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XL, fig. 11. Collected by David White. Specimens in U. S. Nat. Mus.

Diospyros apiculata Lesquereux?

Pl. XL, figs. 4–6.

Diospyros apiculata Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 110, pl. 14, fig. 3; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.
Rhamnus pfaffiana Heer, Hollick, Trans. New York Acad. Sci., vol. 11, 1892, pl. 4, fig. 3.

These leaves have the nervation of *Diospyros* and the general form of this species, but unfortunately, in each specimen the characteristic apex is lacking, so that positive identification is not possible.

Locality: Princess Bay, Staten Island, Pl. XL, fig. 4. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Gay Head, Marthas Vineyard, Pl. XL, fig. 5. Collected by David White. Specimen in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. XL, fig. 6. Collected by David White. Specimen in U. S. Nat. Mus.

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[a] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, pl. 18, fig. 11; ibid., vol. 7, pl. 61, figs. 5a, 5b, 5c.
[b] Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, pl. 20, figs. 1-3.

Diospyros provecta Velenovsky.

Pl. XL, figs. 7–10.

Diospyros provecta Vel., Fl. Böhm. Kreideform., pt. 3, 1884, p. 2 (49), pl. 8 (23), figs. 1–5, 10.
Rhamnus Pfaffiana Heer, Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 103, pl. 4, fig. 1.
Diospyros Steenstrupi Heer, Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 34, pl. 3, fig. 8.
Myrsine elongata Newb, Hollick, Bull. New York Bot. Gard., vol. 2, 1902, p. 405, pl. 41, fig. 2.

These leaves, which all show the characteristic nervation of *Diospyros*, are hardly separable from some which may be found included under *D. apiculata* Lesq. in this monograph. The latter, however, are generally broader and with the secondary nervation diverging at a somewhat more obtuse angle. The Tertiary species *D. brachysepala* A. Br.[a] is more nearly like our figures than is either of the others mentioned, as may be seen by a comparison with the figures by Heer,[b] but it is hazardous to regard this species as having such a great vertical range as identity between them would imply.

A narrow form of *D. primæva* Heer[c] is almost certainly identical with *D. provecta* Vel., as here recognized, and in any revision of the genus I would have no hesitation in so including it.

Locality: Chappaquiddick, Marthas Vineyard, Pl. XL, fig. 7. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Tottenville, Staten Island, Pl. XL, figs. 8, 10. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Gay Head, Marthas Vineyard, Pl. XL, fig. 9. Collected by David White. Specimen in U. S. Nat. Mus.

Diospyros pseudoanceps Lesquereux.

Pl. XL, fig. 3.

Diospyros pseudoanceps Lesq., Mon. U. S. Geol. Survey, vol. 17 (Fl. Dak. Gr.), 1892, p. 111, pl. 22, fig. 1.
Diospyros primæva Heer, Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 236, pl. 7, fig. 5; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r51.

There seems to be but little doubt that our specimen is identical with this species, according to the single figure given by Lesquereux (loc. cit.), but it must be admitted that some of the specific distinctions recognized in this genus are not altogether satisfactory.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Diospyros prodromus Heer?.

Pl. XL, fig. 12.

Diospyros prodromus Heer, Fl. Foss. Arct., vol. 3 (Kreide-Fl.), 1874, p. 113, pl. 28, fig. 6c; pl. 32, figs. 3–7.

Heer's figures of this species are not very satisfactory, but his fig. 3 agrees essentially with ours, in which the characteristic horizontal tertiary nervation of the genus is discernible to a limited extent.

Locality: Glen Cove, Long Island. Collected by David White. Specimen in U. S. Nat. Mus.

[a] Br. and Leonh., Jahrb. Mineral., 1845, p. 170.
[b] Fl. Tert. Helvet., vol. 3, 1859, pl. 102, figs. 1–14.
[c] Fl. Foss. Arct., vol. 7, 1883, pl. 61, fig. 5c.

Order GENTIANALES.

Family ASCLEPIADACEÆ.

PERIPLOCA CRETACEA, n. sp.

Pl. XL, fig. 16.

Leaf elliptical to slightly obovate in outline, 1 decimeter long by about 3 centimeters maximum width, entire, tapering to an acute base and abruptly narrowed to a long acute apex; midrib flexuous, thick at the base and relatively thin above; secondary nervation fine, close, leaving the midrib at acute angles of divergence and connected by fine reticulated tertiary cross nervation.

This leaf is unique in our collection and I have been unable to compare it with any described species from elsewhere, although it is suggestive of several which have been included, under other generic names, in the Asclepiadaceæ and Apocynaceæ, from the Tertiary of Europe.[a]

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Order RUBIALES.

Family CAPRIFOLIACEÆ.

VIBURNUM HOLLICKII Berry.

Pl. XL, fig. 17.

Viburnum Hollickii Berry, Am. Nat., vol. 37, 1903, p. 683, figs. 5, 6, p. 678.
Grewiopsis viburnifolia Ward, Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 59, pl. 174, fig. 8.

This specimen is almost certainly a small form of this species and not a *Grewiopsis*, as originally identified by me. Its similarity to *Viburnum* was noted by me (loc. cit.), but at that time there was no described species in the genus with which it could be satisfactorily compared, and I did not think it advisable to base the description of a new species upon such a fragmentary specimen.

Locality: Lloyd Neck, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

VIBURNUM INTEGRIFOLIUM Newberry.

Pl. XL, fig. 1.

Viburnum integrifolium Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 125, pl. 41, fig. 1; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 54, pl. 177, fig. 7; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r51.

I am of the opinion that Newberry's reference of this species to the genus *Viburnum* was questionable, but there is no doubt that our specimen is identical with his *V. integrifolium* (loc. cit.) from the Cretaceous of New Jersey, and I have retained the name in full in order to avoid any possible confusion which might result in placing it under some other genus.

Locality: Glen Cove, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

[a] *Apocynophyllum æningense* Heer, Fl. Tert. Helv., vol. 3, 1859, p. 21, pl. 104, fig. 4; *Acerates veterana* Heer, ibid., p. 20, pl. 104, fig. 5, etc

DICOTYLEDONOUS LEAVES OF UNCERTAIN RELATION.

Dewalquea grönlandica Heer?

Pl. VIII, fig. 25.

Dewalquea grönlandica Heer, Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 87, pl. 29, figs, 18, 19; pl. 42, figs. 5, 6; pl. 44, fig. 11; Newberry, Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 129, pl. 41, figs. 2, 3, 12; Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 423, pl. 36, fig. 7; Berry, Bull. New York Bot. Gard., vol. 3, 1903, p. 98, pl. 57, fig. 3.

Whatever may be thought of our specimen in comparison with the type figures of Heer (loc. cit.), it agrees quite well with his subsequent figures,[a] and is undoubtedly identical with the specimens so referred by Newberry (loc. cit.) from the Cretaceous of New Jersey.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Dewalquea insignis Hosius and von der Marck?

Pl. VIII, fig. 24.

Dewalquea insignis Hos. and v. d. Marck, Paleontog., vol. 26, 1880, p. 172 (48), pl. 32, figs. 111–113; pl. 33, fig. 109; pl. 34, fig. 110; Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 36, pl. 1, fig. 9.

This specimen is too fragmentary to base on it a positive determination, but it is sufficiently like some of the leaves of this species for at least a provisional reference.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Premnophyllum trigonum Velenovsky.

Pl. XL, figs. 13, 14.

Premnophyllum trigonum Vel., Fl. Böhm. Kreideform., pt. 3, 1884, p. 4 (51), pl. 3 (18), fig. 2; Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 416, pl. 79, fig. 1.

It is exceedingly doubtful if this species, as indicated in the generic name, belongs in the Verbenaceæ, and, indeed, Velenovsky subsequently renamed it *Cissophyllum exulum*,[b] with the idea that it was more likely to be related to the Vitaceæ. As long therefore as its botanical relationships are in doubt I have not thought it advisable to disturb its original name.

Locality: Glen Cove, Long Island, Pl. XL, fig. 13. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Gay Head, Marthas Vineyard, Pl. XL, fig. 14. Collected by David White. Specimen in U. S. Nat. Mus.

Phyllites poinsettioides Hollick.

Pl. XXXIII, fig. 1.

Phyllites poinsettioides Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 37, pl. 1, fig. 10.

Only the type specimen of this species is known to me, the original figure of which is here reproduced.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

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[a] Fl. Foss. Arct., vol. 7, 1883, pl. 62, figs. 5, 6.

[b] Abh. K. Böhm. Gesellsch. Wissensch., vol. 3 (Kvet. Cesk. Cenomanu), 1889, p. 24, pl. 6, figs. 4, 5.

FLOWERS, FRUIT, AND ROOTLETS OF UNCERTAIN RELATION.

Williamsonia problematica (Newberry) Ward.

Pl. V, figs. 27–32.

Williamsonia problematica (Newb.) Ward, Fifteenth Ann. Rept. U. S. Geol. Survey, 1893–94 (1895), p. 382.
Palæanthus (Williamsonia) problematicus Newb. Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 125, pl. 25, figs. 1–9; Hollick, Bull. Geol. Soc. Am., vol. 7, 1895, p. 13.

This exceedingly interesting species has been so fully described and illustrated by Newberry (loc. cit.) that any extended discussion here would be superfluous, and a careful examination of our specimens has resulted in adding nothing which could serve to throw any further light upon its probable botanical relationships, although certain forms, such as are represented by our figs. 27–30, seem to connect it more closely than was at first suspected with *Williamsonia cretacea* Heer,[a] which he regarded as belonging in the Balanophoraceæ. The genus, however, has been shifted and referred by competent authorities to so many different orders and families that I have thought it safer to regard its systematic position as yet unsettled.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Williamsonia Riesii Hollick.

Pl. V, figs. 25, 26.

Williamsonia ? Riesii Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 37, pl. 1, figs. 2, 3.

This organism was originally referred to the genus *Williamsonia* with some hesitation on account of the fragmentary character of the remains, and it may be seen to be strikingly similar in its general adpearance to *Lepacyclotes circularis* Emmons,[b] which Ward placed under "Plants of doubtful affinity" (loc. cit.), and which Fontane regarded as the cone of a Gymnosperm.[c]

Mr. W. A. Seward, in a discussion of our specimen, says "it is probably a true *Williamsonia*," and places it under "*Bennetites (Williamsonia) Flores*;"[d] but whether it should be regarded as generically identical with *W. problematica* is perhaps open to question.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Strobilites perplexus n. sp.

Pl. II, fig. 43.

Organism consisting of an elongated, ellipsoidal, pitted nucleus, attached to a relatively thick stem or petiole and with a series of overlapping, strap-shaped, longitudinally striated, petaloid appendages, arranged like a fan around the exterior.

I have been unable to find a description or figure of any fossil with which this specimen may be satisfactorily compared, although it has some features in common

[a] Fl. Foss. Arct., vol. 6 (abth. 2), 1882, p. 59, pl. 12, fig. 1; pl. 13, fig. 9.
[b] Fide Ward, Twentieth Ann. Rept. U. S. Geol. Survey, pt. 2, 1898–99 (1900), p. 311, pl. 47, fig. 4.
[c] *Araucarites carolinensis* Font., Mon. U. S. Geol. Survey, vol. 6 (Older Mesoz. Fl. Va.), p. 119.
[d] Catalogue of the Mesozoic Plants in the Department of Geology, British Museum, etc., pt. 2, Gymnospermæ, 1895, pp. 155, 156.

with *Antholithes nymphæoides* Hos.,[a] from the Cretaceous of Westphalia, which the author subsequently renamed *Pistites loriformis*.[b]

Our specimen, however, was apparently a cone or strobile, similar to those of *Magnolia*, with which genus I am inclined to think it belongs.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Tricarpellites striatus Newberry.

Pl. VII, fig. 1.

Tricarpellites striatus Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 132, pl. 46, figs. 9–13.

These organisms are very abundant in certain layers of the Amboy clays, but the specimen here figured is the only one thus far found within the insular area.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Tricalycites major Hollick.

Pl. V, figs. 13–22.

Tricalycites major Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 416, pl. 72, figs. 3–7.
"*Pinus*, sp." Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 31, pl. 1, fig. 19.
"Winged seed." Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 62, pl. 180, fig. 1.

This species was originally described in part (loc. cit.) as consisting of "Three entire, oblong-spatulate wings or appendages, . . . middle one usually the largest." With the material now in our possession, however, the following amended description seems to be advisable:

Organism consisting of two (or, possibly, three) entire, longitudinally striated, oblong-spatulate wings or appendages, 2–4 centimeters long by 1–1.3 centimeters wide, attached to a common nucleus.

The indications of a tripartite arrangement are quite vague, even in our figs. 20, 21, while figs. 14–16, if they were the only specimens known, would undoubtedly be described as consisting of but two appendages of equal size. Figs. 13 and 22 are somewhat doubtfully included, but they apparently represent detached wings.

Locality: Tottenville, Staten Island, Pl. V, fig. 13. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Gay Head, Marthas Vineyard, Pl. V, fig. 14. Collected by David White. Specimen in U. S. Nat. Mus.

Nashaquitsa, Marthas Vineyard, Pl. V, figs. 15, 17. Collected by David White. Specimens in U. S. Nat. Mus.

Glen Cove, Long Island, Pl. V, figs. 16, 18–22. Collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard.

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[a] Palaeontogr., vol. 17, 1869, p. 102, pl. 17, figs. 35, 36.
[b] Palaeontogr., vol. 26, 1880, p. 182 (58), pl. 38, figs. 151, 152.

Tricalycites papyraceus Newberry.

Pl. V, figs. 8–12.

Tricalycites papyraceus Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 132, pl. 46, figs. 30–38; Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 63, pl. 180, fig. 8; Annals New York Acad. Sci., vol. 11, 1898, p. 61, pl. 3, fig. 6; ibid., p. 423, pl. 37, figs. 1, 2; Bull. New York Bot. Gard., vol. 2, 1902, p. 405, pl. 41, fig. 3; Fifty-fifth Ann. Rept. New York State Mus., 1901 (1903), p. r51; Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 81, pl. 1, fig. 4.

These organisms, as described and figured by Newberry (loc. cit.), are always 3-lobed or winged, with the middle one larger than the other two, as is the case in our figs. 8, 9, in regard to the identity of which there can be no question. The fragment represented by our fig. 10, however, is manifestly too imperfect for positive identification, and in figs. 11, 12 the tripartite divisions are not well defined and the indications are that in any event these were all about equal in size. For this reason the identity of the latter three figures is perhaps questionable, and it is possible that they may represent small specimens of *T. major* Hollick, the species last described.

Locality: Tottenville, Staten Island, Pl. V, figs. 8, 9. Collected by Arthur Hollick. Specimens in Mus. Staten Island Assn. Arts and Sci.

Balls Point, Block Island, Pl. V, fig. 10. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Chappaquiddick, Marthas Vineyard, Pl. V, fig. 11. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Lloyd Neck, Long Island, Pl. V, fig. 12. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

Calycites obovatus n. sp.

Pl. V, fig. 23.

Organism consisting of a petioled nucleus, to which are attached two entire, obovate, longitudinally striated, wing-like appendages, each about 1.5 centimeters long by 1.3 centimeters in maximum width.

This specimen is intermediate in size and shape between the species last described and certain forms of *Tricalycites major* Hollick,[a] with which species it may eventually have to be included. It is, however, unquestionably 2-winged, and the wings are shorter and relatively broader than in any recognized specimens of the latter.

Locality: Nashaquitsa, Marthas Vineyard. Collected by David White. Specimen in U. S. Nat. Mus.

Calycites alatus Hollick.

Pl. V, fig. 24.

Calycites alatus Hollick, Bull. New York Bot. Gard., vol. 3, 1904, p. 417, pl. 72, fig. 8.
Tricalycites papyraceus Newb., Hollick, Trans. New York Acad. Sci., vol. 15, 1895, p. 6.

This species may perhaps be regarded as a small form of the one last described and possibly as one extreme of a series of forms of which the other extreme is represented by *Tricalycites major*.

Locality: Montauk Point, Long Island. Collected by Arthur Hollick. Specimen in Mus. New York Bot. Gard.

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[a] See this monograph, Pl. V, figs. 16, 17.

Carpolithus euonymoides n. sp.

Pl. VII, fig. 2.

Carpolithus sp. Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 38, pl. 1, fig. 4.

This fruit is suggestive of *Celastrus* or *Euonymus*, although it appears to have had more than five carpels, which are not unlike the detached seeds shown in figs. 9, 10.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Carpolithus vaccinioides n. sp.

Pl. VII, figs. 19, 19a.

Carpolithus sp. Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 38, pl. 1, figs. 16, 16

In general appearance these remains are suggestive of a raceme of some species of *Vaccinium*, although the details of the inflorescence seem to be more like those of some glumaceous plant. The specific name is therefore to be considered as merely indicative of its superficial aspect.

Locality: Kreischerville, Staten Island. Fig. 19 nat. size; fig. 19a enlarged. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Carpolithus floribundus Newberry.

Pl. VII, figs. 20, 21.

Carpolithus floribundus Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 133, pl. 46, figs. 17–21.

It is perhaps not certain that these specimens are identical with Newberry's species, but their points of resemblance are certainly very similar and the slight differences which might be noted would be difficult to define.

Locality: Gay Head, Marthas Vineyard. Collected by David White. Specimens in U. S. Nat. Mus.

Carpolithus hirsutus Newberry.

Pl. VII, figs. 3–8.

Carpolithus hirsutus Newb., Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays), 1895 (1896), p. 134, pl. 46, figs. 14, 14a.

"*Carpolithus spinosus* Newb.," Hollick, Bull. Geol. Soc. Am. vol. 7, 1895, p. 13.

The characters of this species are so well defined that there is no difficulty in identifying it. The remains are found in relative abundance in the Amboy clays, and a number of specimens are included in the collections from Gay Head.

Locality: Gay Head, Marthas Vineyard. Figs. 3–5 collected by Arthur Hollick. Specimens in Mus. New York Bot. Gard. Figs. 6–8 collected by David White. Specimens in U. S. Nat. Mus.

CARPOLITHUS sp.

Pl. VII, figs. 9, 10.

Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 38, pl. 1, fig. 8.

Locality: Kreischerville, Staten Island, Pl. VII, fig. 9. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Gay Head, Marthas Vineyard, Pl. VII, fig. 10. Collected by David White. Specimen in U. S. Nat. Mus.

CARPOLITHUS sp.

Pl. VII, fig. 11.

Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 38, pl. 1, fig. 6.

Locality: Green Ridge, Staten Island. Collected by Heinrich Ries. Specimen in Mus. Staten Island Assn. Arts and Sci.

CARPOLITHUS sp.

Pl. VII, fig. 12.

Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 38, pl. 1, fig. 11.

Locality: Kreischerville, Staten Island. Collected by Wm. T. Davis. Specimen in Mus. Staten Island Assn. Arts and Sci.

CARPOLITHUS sp.

Pl. VII, fig. 13.

Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 38, pl. 1, fig. 12.

Locality: Kreischerville, Staten Island. Collected by Wm. T. Davis. Specimen in Mus. Staten Island Assn. Arts and Sci.

CARPOLITHUS sp.

Pl. VII, fig. 14.

Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 39, pl. 1, fig. 15.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

CARPOLITHUS sp.

Pl. VII, fig. 15.

Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 39, pl. 1, fig. 14.

Locality: Kreischerville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

Rhizomorphs.

Pl. VI, fig. 13.

Rhizomorphs, Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 423, pl. 38, fig. 1.

These peculiar fossils are especially abundant in nodules of hard clay ironstone at Tottenville, Staten Island, and I have found traces of them elsewhere. They usually consist of filamentous carbonaceous matter, more or less branching, encased in limonite. When the carbonaceous matter is absent only a tube of limonite remains, and where these appear at the surface they give rise to pit-like markings. The term rhizomorph was adopted for the reason that it was used by Dr. J. I. Northrop in his description of somewhat simliar cylindrical structures in the coral rocks of the island of Nassau,[a] which he concluded were caused by concretionary structure around the roots of plants. In our specimens it is difficult to determine what was the original position of the matrix, but apparently the tubes are more or less at right angles to the original plane of deposition, in which case it is probable that the rhizomorphs represent the remains of rootlets in place, and they therefore may or may not be Cretaceous in age. Post-Cretaceous vegetation, whose rootlets extend into a bed of Cretaceous clay, might equally well produce such a result. Whatever their true nature and origin may be, however, these remains are exceedingly characteristic and are worthy of description.

Locality: Tottenville, Staten Island. Collected by Arthur Hollick. Specimen in Mus. Staten Island Assn. Arts and Sci.

[a] Trans. New York Acad. Sci., vol. 10, 1890, p. 16.

BOTANICAL DISCUSSION.

BOTANICAL RELATIONSHIPS OF THE FLORA.

If the entire flora is regarded from the standpoint of the subkingdoms represented, it may be seen that the Pteridophyta form a very insignificant element, and this is true not only in the number of species but also in the actual number of specimens collected. Six species, included in 5 genera, are all that we have thus far been able to identify, and most of these are fragmentary, whereas in the Amboy clays at least 10 species of ferns alone are known and several of these occur in considerable abundance at certain horizons which we have reason to believe are represented in the insular formations. Recent discoveries of ferns in new exposures at Kreischerville, Staten Island, point strongly in this direction and indicate that additions to the pteridophytic flora may be expected from this locality when the exposures have been more fully examined.

In the Spermatophyta, in a total of 91 genera and 216 species, the gymnosperms and angiosperms number 14 genera and 27 species and 77 genera and 189 species, respectively. In the former 2 species are regarded as belonging to the Cycadales and the remainder to the Coniferales, while the angiosperms are represented by 4 genera and 4 species of Monocotyledones, and 73 genera and 185 species of Dicotyledones. The occurrence of the former class at the Long Island and Marthas Vineyard localities may possess some significance, inasmuch as not a single species which could be included in it has as yet been found in the Amboy clays, although some questionable remains are described from the Cliffwood clay marls.

The greatest interest naturally centers around the Dicotyledones, in which 146 species are included in the Choripetalæ, 16 in the Gamopetalæ, and 23 are regarded as of uncertain relation. The Ranales is the largest order, including 5 families, 16 genera, and 55 species. Of these the largest family is the Magnoliaceæ, with 3 genera and 22 species, and the largest genus, *Magnolia*, with 14 species.

The occurrence of several aquatic and semiaquatic plants, such as *Nelumbo*, *Marsilea*, *Typha*, and *Cyperacites*, is interesting for the reason that they appear to be confined to Long Island and Marthas Vineyard, and may indicate either that peculiar local conditions prevailed there or else that they are elements of a flora belonging to a different horizon from any known on Staten Island.

It is unfortunate that the botanical relationships of some of the most abundant and characteristic elements should be in doubt, but there is no question that the facts are not yet at hand with which to satisfactorily determine the systematic position of the species included under such genera as *Liriodendropsis* and *Williamsonia*.

Their external characters are well defined and for this reason they will always be of stratigraphic value wherever found, but the problem of their exact biologic affinities remains to be solved.

Finally, a word should be said in regard to the determinations of the coniferous remains, all of which have been referred to well-known fossil or living genera and most of them to well-known Cretaceous species, solely upon their external characters. These remains consist of leaves, twigs, cones, and cone scales, often completely dissociated one from the other and yet in many instances apparently belonging to the same genus or species. The actual relationship between specimens, as implied in the names, may therefore be not always correct, and on the other hand specimens to which different generic or specific names have been applied may belong to the same species, and in this connection a wide and interesting field for future investigation is open, in the examination of the internal structure of the specimens, when these are sufficiently well preserved to be sectioned and studied under the microscope. The lignites, which occur in great abundance at many horizons, also offer unlimited material for the future investigator, and their identification would undoubtedly throw a flood of light upon the genera which are represented in the flora, and in many instances would undoubtedly assist in correctly identifying and associating dismembered parts of species.

It may also be remarked in connection with the gymnosperms that the number of species described does not give a correct idea of the actual proportion of this class of plants to the entire flora. It is probable that this proportion was considerably greater than the number of species would imply, as quantities of unidentified material are undoubtedly gymnospermous. A superficial examination of the lignites alone proves this to be the case, and much of the macerated material which forms layers in the clays, especially at Kreischerville, also belongs in the same class.

In the following table is given the number of species in the insular flora opposite each subdivision of the vegetable kingdom in which they belong:

Systematic tabulation of the insular flora, showing number of species.

Subdivisions.	Number of species.	Subdivisions.	Number of species.
Pteridophyta	6	Spermatophyta—Continued.	
Filicales	4	Gymnospermæ—Continued.	
Gleicheniaceæ	2	Coniferales	25
Gleichenia	2	Gingkoaceæ	3
Cyatheaceæ	1	Czekanowskia	1
Thyrsopteris	1	Baiera	1
Polypodiaceæ	1	Protophyllocladus	1
Onoclea	1	Pinaceæ	22
Salviniales	2	Dammara	3
Marsiliaceæ	2	Pinus	1
Marsilea	1	Cunninghamites	1
Sagenopteris	1	Sequoia	8
Spermatophyta	216	Brachyphyllum	1
Gymnospermæ	27	Widdringtonites	3
Cycadales	2	Frenelopsis	1
Cycadaceæ	2	Moriconia	1
Podozamites	2	Cyparissidium	1

Systematic tabulation of the insular flora, showing number of species—Continued.

Subdivisions.	Number of species.
Spermatophyta—Continued.	
Gymnospermæ—Continued.	
Coniferales—Continued.	
Pinaceæ—Continued.	
Juniperus	1
Cone scale, undetermined	1
Angiospermæ	189
Monocotyledonæ	4
Pandanales	1
Typhaceæ	1
Typha	1
Graminales	2
Poaceæ	1
Poacites	1
Cyperaceæ	1
Cyperacites	1
Liliales	1
Liliaceæ	1
Majanthemophyllum	1
Dicotyledonæ	185
Choripetalæ	146
Salicales	12
Salicaceæ	12
Populus	4
Salix	8
Myricales	4
Myricaceæ	4
Myrica	4
Juglandales	3
Juglandaceæ	3
Juglans	3
Fagales	3
Fagaceæ	3
Quercus	3
Urticales	8
Ulmaceæ	1
Planera	1
Moraceæ	7
Ficus	7
Proteales	3
Proteaceæ	3
Proteoides	1
Dryandroides	1
Banksites	1
Ranales	55
Nymphæaceæ	1
Nelumbo	1
Menispermaceæ	7
Menispermites	3
Cocculus	2
Cocculites	2
Magnoliaceæ	22
Magnolia	14
Spermatophyta—Continued.	
Angiospermæ—Continued.	
Dicotyledonæ—Continued.	
Choripetalæ—Continued.	
Ranales—Continued.	
Magnoliaceæ—Continued.	
Liriodendron	3
Liriodendropsis	5
Anonaceæ	1
Guatteria	1
Lauraceæ	24
Cinnamomum	5
Persea	2
Ocotea	1
Nectandra	1
Sassafras	5
Malapoenna	1
Laurus	7
Laurophyllum	2
Rosales	16
Platanaceæ	3
Platanus	3
Rosaceæ	1
(Pomaceæ)	1
Amelanchier	1
Leguminosæ	12
(Cæsalpiniaceæ)	3
Hymenæa	2
Cassia	1
(Papilionaceæ)	6
Colutea	1
Dalbergia	3
Phaseolites	2
Leguminosæ of uncertain relation	3
Leguminosites	3
Sapindales	13
Anacardiaceæ	2
Rhus	1
Pistacia	1
Ilicaceæ	1
Ilex	1
Celastraceæ	5
Celastrus	1
Celastrophyllum	1
Gyminda	1
Elæodendron	2
Aceraceæ	2
Acer	2
Sapindaceæ	3
Sapindus	3
Rhamnales	10
Rhamnaceæ	9
Paliurus	3

Systematic tabulation of the insular flora, showing number of species—Continued.

Subdivisions.	Number of species.
Spermatophyta—Continued.	
Angiospermæ—Continued.	
Dicotyledonæ—Continued.	
Choripetalæ—Continued.	
Rhamnales—Continued.	
Rhamnaceæ—Continued.	
Zizyphus	4
Rhamnus	1
Ceanothus	1
Vitaceæ	1
Cissites	1
Malvales	4
Sterculiaceæ	4
Sterculia	3
Pterospermites	1
Myrtales	6
Myrtaceæ	6
Eucalyptus	5
Myrtophyllum	1
Umbellales	9
Araliaceæ	9
Hedera	1
Aralia	6
Panax	1
Chondrophyllum	1
Gamopetalæ	16
Ericales	5
Ericaceæ	5
Kalmia	1
Andromeda	4
Spermatophyta—Continued.	
Angiospermæ—Continued.	
Dicotyledonæ—Continued.	
Gamopetalæ—Continued.	
Primulales	3
Myrsinaceæ	3
Myrsine	2
Myrsinites	1
Ebenales	5
Ebenaceæ	5
Diospyros	5
Gentianales	1
Asclepiadaceæ	1
Periploca	1
Rubiales	2
Caprifoliaceæ	2
Viburnum	2
Dicotyledonous leaves of uncertain relation	4
Dewalquea	2
Premnophyllum	1
Phyllites	1
Flowers, fruit, and rootlets of uncertain relation	19
Williamsonia	2
Strobilites	1
Tricarpellites	1
Tricalycites	2
Calycites	2
Carpolithus	10
Rhizomorphs	1

In the total known insular flora, consisting of 222 species, 31 are described as new in this monograph and 25 others have not yet been found elsewhere. Of these apparently localized species several are deserving of special mention, such as *Onoclea inquirenda* (Hollick), which apparently represents the fertile frond of a fern; *Marsilea Andersoni* Hollick, the first satisfactory fossil representative of this genus found in America, and the angiospermous leaves of uncertain systematic position included under *Liriodendropsis spectabilis* n. sp., which are apparently extreme forms of the many which are referred to this protean genus.

The three new species, *Guatteria cretacea*, *Ocotea nassauensis*, and *Gyminda primordialis* also add three genera new to the Cretaceous flora of North America.

STRATIGRAPHICAL AND AREAL DISTRIBUTION OF THE FLORA.

In the correlation table the stratigraphic position of the plant-bearing deposits, as interpreted by a number of geologists, is indicated, and it now remains to discuss the evidence in this connection afforded by the included plant remains thus far identified.

Of the 222 species described in this monograph, about 60 are known to occur in the Raritan formation at Sayreville, Woodbridge, and South Amboy, N. J., and

some 40 or more in the Cliffwood formation, at Cliffwood, in the same State. Excluding some species of doubtful identity, there are about 20 species in the insular flora common to both formations.

On the other hand, the insular flora contains more than 100 well-defined species and a number of other doubtful ones which have not yet been recorded from any of the New Jersey horizons. Some of these species are so well defined that they could hardly have escaped attention had they been present in any of the collections made in New Jersey, but recent discoveries by Mr. Edward W. Berry, kindly reported to me, have demonstrated that further collecting will undoubtedly result in adding several of the insular forms to the New Jersey list. In a recent communication transmitted to me by Mr. Berry, relating to material collected at Morgans and at the pits of the Cliffwood Brick Company during the year 1905, a number of additions to the Cretaceous flora of New Jersey are given, which include *Magnolia Capellinii* Heer, *Nelumbo Kempii* Hollick, *Salix protexfolia flexuosa* (Newb.) Lesq., and *Cinnamomum Heerii* Lesq., which I have therefore included in the table of distribution for those locations. The first two are of special interest, for the reason that their comparative abundance on Long Island and Marthas Vineyard caused them to be regarded as characteristic of the formation at these localities and it was recognized that if the same species were found at other places they would serve as important correlation factors. Of yet further significance in connection with this flora, made known by Mr. Berry, may also be noted the occurrence of another species of *Nelumbo* (*N. primaeva* Berry), which, however, Mr. Berry is now inclined to consider as a small form of *N. Kempii*, and a *Salvinia* (*Salvinia* sp.), both of which genera are represented in the insular flora on Long Island, but not in that of the Amboy clays as described by Newberry.

The beds from which Mr. Berry's collections were made are intermediate in their stratigraphic position between the typical Raritan plastic clays of the Woodbridge and Amboy horizons and the typical Cliffwood clay marls of the Cliffwood bluff, and may therefore be expected to yield a number of species not found either below or above them, and the probabilities are that among these, when further collections are made, will be included other species of the insular flora which have not as yet been discovered on the mainland.

In this connection it may be pertinent to quote the following abstract from pages 415 and 416 of my paper on "Additions to the Palaeobotany of the Cretaceous Formation on Staten Island, No. II,"[a] written before the above mentioned discoveries of Mr. Berry were reported:

> It was previously taken for granted that all the Cretaceous strata on Staten Island were continuations of those at Perth Amboy and Woodbridge, and that the fossil plants found in them or derived from them would prove to be identical with those of the mainland. Such, however, has not been found to be the case, and this fact has seemed to indicate that some of the strata from which the Staten Island plants were derived may represent a different and presumably a higher member of the Amboy clay series than do those represented at the New Jersey localities mentioned. * * * If a geological map of New Jersey be examined and the trend of the clay outcrops be theoretically extended on to Staten Island, it may be readily seen that the lower beds, represented by those at Woodbridge, Sayreville, Perth Amboy, and possibly South Amboy, would strike the western shore of Staten Island in the vicinity of Tottenville and Kreischerville, while the upper beds, represented by

[a] Annals New York Acad. Sci., vol. 11, 1898, pp. 415–430.

those in the vicinity of Cheesequake Creek [Morgans], would strike along the southern shore of the island from Tottenville to Arrochar.

This probability is further strengthened by the fact that marl bed fossils [invertebrates] have been found in the moraine at the latter locality, showing that strata even higher than the upper members of the clay series are or once were represented there.

From a consideration of these facts and other similar ones in connection with the Cretaceous clays on Staten Island, Long Island, Block Island, and Marthas Vineyard, the name "Island series" was given by Dr. Lester F. Ward to the strata represented on these islands.

The "Island series" would therefore lie above the Amboy clays, as described by Newberry,[a] and below those of the clay marls at Cliffwood, as described by me in a recent paper.[b]

The striking manner in which the theory as above outlined has been verified by a critical examination of all the available paleontologic evidence and by subsequent investigations in the field is exceedingly gratifying, and we are now in a position to state with almost absolute certainty that the Kreischerville beds are the equivalents of those at Woodbridge and Amboy and that on Long Island and eastward the deposits include not only these, but also the higher strata represented on the mainland by those at Morgans and Cliffwood; and the fact that plants from all these horizons, as well as invertebrate remains from yet higher, are abundant in the moraine throughout indicates that the strata from which they were derived formerly existed over an area farther to the north than where they are now exposed and probably included a large part of what is now Long Island Sound, whence they were eroded by glacial action during the Quaternary period.

A comparison of our flora with that of the Dakota group shows that at least 58 species, and perhaps more, are identical with species of that group, indicating a close relationship, which would be rendered even more striking by including in the comparison the Cretaceous flora of New Jersey. It is worthy of note, however, that, in the West, Dakota types of plants occur in the Judith River beds, which are of Senonian age and separated from the Dakota by more than 1,000 feet of marine sediments.

Comparing the flora next with those of the Kome, Atane, and Patoot beds of Greenland, it may be seen that 54 of our species, some of them the most characteristic, are represented in those horizons. Of these species, only 9 occur in the Kome, and it is significant that the identity of 6 of these is questioned; 40 occur in the Atane and 23 in the Patoot beds, including 14 common to both, and a critical analysis seems to indicate a closer relationship with these latter, regarded as a floral unit, than with the Dakota flora. This relationship is indicated not so much by the actual number of species in common as it is by the relative abundance of certain species which may be regarded as characteristic, such as *Cunninghamites elegans* (Corda) Endl., *Widdringtonites Reichii* (Etts.) Heer, *Moriconia cyclotoxon* Deb. and Etts., *Dammara borealis* Heer, *Nelumbo Kempii* (Hollick) Hollick (probably identical with *Nelumbium arcticum* Heer), *Liriodendropsis simplex* (Newb.) Newb., *Celastrus arctica* Heer, etc.; and inasmuch as none of the above is recognized as a typical Dakota-group species, the relationship of our eastern Cretaceous flora with that of Greenland may be regarded as closer than with that of our Western States. Heer considered the Atane flora to be probably Cenomanian, while he recognized

[a] Mon. U. S. Geol. Survey, vol. 26 (Fl. Amboy Clays).

[b] The Cretaceous clay marl exposure at Cliffwood, N. J.: Trans. New York Acad. Sci., vol. 16, 1897, pp. 124–136.

that the fauna of the Patoot beds proved them to be Senonian. The observations of White and Schuchert[a] have confirmed the reference of the Patoot beds to the Senonian, and they also show such close faunal and stratigraphic relations between the two series as to make it probable that the lower Atane beds are Senonian. We may therefore consider our insular flora and its equivalents on the mainland as, in part at least, Senonian in age, with possibly the oldest portion of it as old as late Cenomanian. Whether Turonian time is represented in the sediments and floras of the region must be left for future investigation. It is interesting to note in this connection that the fauna of the Cliffwood clays as recently listed by Weller[b] shows only Senonian affinities.

No attempt has been made at an exhaustive comparison with the Cretaceous flora of Europe, but an examination of the Senonian flora of Quedlinburg, in Saxony, and of the Cenomanian flora of Moletein, in Saxony, described by Heer, and that of Bohemia, described by Velenovsky and Bayer, shows that our insular flora is closely related to all of them, as they contain such characteristic species as *Dammara borealis* Heer, *Widdringtonites Reichii* (Etts.) Heer, *Cunninghamites elegans* (Corda) Endl., *Moriconia cyclotoxon* Deb. and Etts., etc.

In the following table the distribution of the insular flora as above outlined is set forth in detail. It might have been extended so as to include the lower Potomac formation of the South and the Laramie and allied formations of the West; but inasmuch as the facts in relation to the distribution of the species which would be thus included are not essential to the solution of the insular flora correlation problem, these features are omitted.

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[a] Cretaceous series of the west coast of Greenland: Bull. Geol. Soc. Am., vol. 9, 1898, pp. 343-368.
[b] Jour. Geol., vol. 13, 1905, pp. 324-337.

Table of distribution of the

[Species marked with an asterisk (*) have been reported only from within the insular area.

Page of this work.	Species.	Marthas Vineyard.			Block Island.			Long Island.							
		Chappaquiddick.	Nashquitsa.	Gay Head.	Balls Point.	Southeast Point.	Black Rock Point.	Montauk Point.	Eatons Neck.	Little Neck (Northport Harbor).	Lloyd Neck.	Cold Spring.	Center Island.	Oak Neck.
31	Gleichenia gracilis Heer?						+							
31	Gleichenia protogæa Deb. and Etts.?			+										
31	Thyrsopteris grevillioides (Heer) n. comb			+										
32	*Onoclea inquirenda (Hollick) n. comb		+	+						+				
33	*Marsilea Andersoni Hollick			+										
34	Sagenopteris variabilis (Vel.) Vel.?	+												
35	Podozamites lanceolatus (Lindl. and Hutt.) Schimp													
35	Podozamites sp.													
36	Czekanowskia dichotoma (Heer) Heer?	+												
36	Baiera grandis Heer?			+										
36	Protophyllocladus subintegrifolius (Lesq.) Berry						+							
37	Dammara boreales Heer	+		+										
39	*Dammara northportensis Hollick									+				
40	*Dammara minor n. sp.				+									
40	Pinus sp.			+										
41	Cunninghamites elegans (Corda) Endl	+												
41	Sequoia heterophylla Vel.													
41	Sequoia ambigua Heer			+										
42	Sequoia Reichenbachi (Gein.) Heer			+										
43	Sequoia fastigiata (Sternb.) Heer?			+										
43	Sequoia gracilis Heer?			+										
43	Sequoia sp.													
43	Cone of Sequoia concinna Heer			+										
44	Cone of Sequoia sp.			+										
44	Brachyphyllum macrocarpum Newb.									+				
44	Widdringtonites Reichii (Etts.) Heer			+										
45	Widdringtonites subtilis Heer			+			+							
45	*Widdringtonites fasciculatus n. sp.			+										
45	Frenelopsis Hoheneggeri (Etts.) Schenk?			+										
46	Moriconia cyclotoxon Deb. & Etts.						+							
46	Cyparissidium gracile (Heer) Heer?													
46	Juniperus hypnoides Heer	+												
47	Cone scale of a Conifer?			+										
47	Typha sp.			+							+			
48	Poacites sp.			+										
48	Cyperacites sp.													
48	Majanthemophyllum pusillum Heer													
49	Populus harkeriana Lesq.													
49	Populus? apiculata Newb.													
49	Populus stygia Heer?			+										
50	Aments of Populus sp.			+										
50	Salix membranacea Newb.			+										
50	Salix cuneata Newb.													
51	Salix Meekii Newb.	+	+											
51	Salix proteæfolia flexuosa (Newb.) Lesq.						+							
52	Salix proteæfolia lanceolata Lesq.			+			+							
52	Salix proteæfolia linearifolia Lesq?			+										

species described in this work.

In the Greenland column A indicates Atane, K indicates Kome, P indicates Patoot.]

Long Island.						Staten Island.						New Jersey.					Dakota group.	Greenland.	Europe.
Dosoris Island.	Glen Cove.	Sea Cliff.	Mott Point (Manhasset Neck).	Elm Point (Great Neck).	Brooklyn.	Arrochar.	Princess Bay.	Richmond Valley.	Tottenville.	Kreischerville.	Green Ridge.	Sayreville.	Woodbridge.	South Amboy.	Morgans.	Cliffwood.			
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Table of distribution of the

Page of this work.	Species.	Marthas Vineyard.			Block Island.			Long Island.						
		Chappaquiddick.	Nashaquitsa.	Gay Head.	Balls Point.	Southeast Point.	Black Rock Point.	Montauk Point.	Eatons Neck.	Little Neck (Northport Harbor).	Lloyd Neck.	Cold Spring.	Center Island.	Oak Neck.
53	*Salix purpuroides Hollick													
53	Salix sp.													
53	*Myrica Davisii Hollick													
53	*Myrica Hollicki Ward													
54	Myrica Zenkeri (Etts.) Vel.?													
54	Ament of Myrica sp.			+										
54	Juglans arctica Heer		+				+							
55	Juglans crassipes Heer			+										
55	*Juglans elongata n. sp.			+										
56	Quercus morrisoniana Lesq.?												+	
56	Quercus (?) novæ-cæsareæ Hollick													
56	Quercus sp.			+										
57	*Planera betuloides n. sp.			+										
57	Ficus myricoides Hollick			+										
57	Ficus fracta Vel.													+
58	Ficus atavina Heer			+										
58	Ficus Krausiana Heer			+		+								
58	*Ficus sapindifolia Hollick			+										
59	*Ficus Willisiana Hollick													
59	Ficus Woolsoni Newb.?													
59	Proteoides daphnogenoides Heer			+										
60	Dryandroides quercinea Vel.			+										
60	Banksites Saportanus Vel.			+										
61	Nelumbo Kempii (Hollick) Hollick			+										
61	*Menispermites Brysoniana Hollick													
62	Menispermites acutilobus Lesq.?		+											
62	Menispermites sp.													
62	*Cocculus minutus Hollick									+				
62	Cocculus cinnamomeus Vel.			+										
63	*Cocculites imperfectus n. sp.			+										
63	*Cocculites inquirendus n. sp.			+										
63	Magnolia Capellinii Heer												+	
64	Magnolia speciosa Heer			+										
64	Magnolia tenuifolia Lesq.			+										
64	Magnolia longipes Newb.?													
65	Magnolia pseudoacuminata Lesq.			+										
65	Magnolia amplifolia Heer			+										
65	Magnolia Lacoeana Lesq.			+										
66	Magnolia longifolia Newb.													
66	Magnolia Isbergiana Heer													
66	Magnolia woodbridgensis Hollick				+									
67	Magnolia glaucoides Newb.?													
67	Magnolia alternans Heer													
67	*Magnolia Van Ingeni Hollick													
67	Magnolia auriculata Newb.			+										
68	Liriodendron oblongifolium Newb.?													
68	Liriodendron primævum Newb.													
68	*Liriodendron attenuatum n. sp.			+										

species described in this work—Continued.

Long Island.						Staten Island.						New Jersey.					Dakota group.	Greenland.	Europe.
Dosoris Island.	Glen Cove.	Sea Cliff.	Mott Point (Manhasset Neck).	Elm Point (Great Neck).	Brooklyn.	Arrochar.	Princess Bay.	Richmond Valley.	Tottenville.	Kreischerville.	Green Ridge.	Sayreville.	Woodbridge.	South Amboy.	Morgans.	Cliffwood.			
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Table of distribution of the

Page of this work.	Species.	Marthas Vineyard.			Block Island.			Long Island.							
		Chappaquiddick.	Nashaquitsa.	Gay Head	Balls Point.	Southeast Point.	Black Rock Point.	Montauk Point.	Eatons Neck.	Little Neck (Northport Harbor).	Lloyd Neck.	Cold Spring.	Center Island.	Oak Neck.
71	Liriodendropsis angustifolia Newb.			+										
71	Liriodendropsis constricta (Ward var.)			+										
72	Liriodendropsis retusa (Heer) n. comb.													
72	Liriodendropsis simplex (Newb.) Newb.			+										
73	* Liriodendropsis spectabilis n. sp.			+										
73	* Guatteria cretacea n. sp.			+										
74	* Cinnamomum crassipetiolatum n. sp.													
74	Cinnamomum intermedium Newb.													
75	Cinnamomum Heerii Lesq.?			+										
75	Cinnamomum membranaceum (Lesq.) n. comb.													
75	Cinnamomum sp.			+										
76	Persea Leconteana (Lesq.) Lesq.			+										
76	* Persea valida n. sp.													
76	* Ocotea nassauensis n sp.													
76	* Nectandra imperfecta n. sp.			+										
77	Sassafras acutilobum Lesq.			+										
77	* Sassafras angustilobum n. sp.			+										
77	Sassafras cretaceum Newb.?			+										
78	Sassafras hastatum Newb.?			+										
78	Sassafras progenitor Newb.													+
78	Malapoenna sp.			+										
79	Laurus nebrascensis (Lesq.) Lesq.	+		+										
79	* Laurus Newberryana Hollick													
80	Laurus Hollae Heer?													
80	Laurus antecedens Lesq.													
80	Laurus teliformis Lesq.			+										
80	Laurus plutonia Heer.						+							
81	Laurus angusta Heer.									+				
81	* Laurophyllum elegans n. sp.													
82	* Laurophyllum nervillosum n. sp.													
82	* Platanus aquehongensis Hollick													
82	Platanus? Newberryana Heer													
83	Platanus sp.													
83	* Amelanchier Whitei n. sp.			+										
83	Hymenæa dakotana Lesq.			+							+			
84	Hymenæa primigenia Sap.			+										
84	Cassia sp.			+										
84	Colutea primordialis Heer.			+					+					
85	Dalbergia hyperborea Heer?													
85	* Dalbergia minor n. sp.			+										
85	* Dalbergia irregularis n. sp.			+										
85	* Phaseolites elegans n. sp.													
86	* Phaseolites manhassettensis Hollick													
86	Leguminosites coronilloides Heer.			+										
86	Leguminosites constrictus Lesq.?													+
86	Leguminosites convolutus Lesq.?			+										
87	Rhus cretacea Heer?													
87	* Pistacia aquehongensis Hollick													

species described in this work—Continued.

Long Island.						Staten Island.						New Jersey.							
Dosoris Island.	Glen Cove.	Sea Cliff.	Mott Point (Manhasset Neck).	Elm Point (Great Neck).	Brooklyn.	Arrochar.	Princess Bay.	Richmond Valley.	Totterville.	Kreischerville.	Green Ridge.	Sayreville.	Woodbridge.	South Amboy.	Morgans.	Cliffwood.	Dakota group.	Greenland.	Europe.
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Table of distribution of the

Page of this work.	Species.	Marthas Vineyard.			Block Island.			Long Island.							
		Chappaquiddick.	Nashaquitsa.	Gay Head.	Balls Point.	Southeast Point.	Black Rock Point.	Montauk Point.	Eatons Neck.	Little Neck (Northport Harbor).	Lloyd Neck.	Cold Spring.	Center Island.	Oak Neck.
87	Ilex papillosa Lesq			+										
88	Celastrus arctica Heer						+			+				
88	Celastrophyllum grandifolium Newb.?		+											
88	*Gyminda primordialis n. sp			+										
89	*Elæodendron strictum n. sp			+										
89	Elæodendron sp													
89	*Acer minutum Hollick													
89	Fruit of Acer sp			+										
90	*Sapindus imperfectus Hollick													
90	Sapindus morrisoni Lesq													
91	Sapindus apiculatus Vel													
91	Paliurus integrifolius Hollick									+	+			+
91	Paliurus ovalis Dawson			+										
92	Paliurus affinis Heer?													
92	*Zizyphus elegans Hollick													
92	*Zizyphus oblongus n. sp													
93	Zizyphus grönlandicus Heer		+	+										
93	*Zizyphus Lewisiana Hollick													+
93	Rhamnus (?) acuta Heer										+			
93	*Ceanothus constrictus n. sp			+										
94	Cissites formosus Heer?													
94	*Sterculia pre-labrusca n. sp			+										
94	Sterculia Snowii Lesq.?			+										
95	Sterculia sp			+										
95	Pterospermites modestus Lesq													
95	Eucalyptus? nervosa Newb						+							
95	Eucalyptus? angustifolia Newb			+						+				
96	Eucalyptus Geinitzi (Heer) Heer			+		+	+							
96	Eucalyptus Schübleri (Heer)? n. comb		+											
97	*Eucalyptus latifolia n. sp			+										
97	Myrtophyllum Warderi Lesq													
97	*Hedera simplex n. sp		+											
98	Aralia patens Newb.?													
98	Aralia palmata Newb													
98	Aralia grönlandica Heer		+	+										
99	Aralia Ravniana Heer			+										
99	*Aralia nassauensis Hollick											?		
99	Aralia coriacea Vel			+										
100	Panax cretacea Heer			+										
100	Chondrophyllum orbiculatum Heer													
100	*Kalmia Brittoniana Hollick													
100	Andromeda latifolia Newb													+
101	Andromeda Parlatorii Heer		+	+										
101	Andromeda flexuosa Newb													
102	Andromeda tenuinervis Lesq													
102	Myrsine elongata Newb										+			
102	Myrsine borealis Heer			+										
103	Myrsinites? Gaudini Lesq													

species described in this work—Continued.

Long Island.						Staten Island.						New Jersey.					Dakota group.	Greenland.	Europe.
Dosoris Island.	Glen Cove.	Sea Cliff.	Mott Point (Manhasset Neck).	Elm Point (Great Neck).	Brooklyn.	Arrochar.	Princess Bay.	Richmond Valley.	Tottenville.	Kreischerville.	Green Ridge.	Sayreville.	Woodbridge.	South Amboy.	Morgans.	Cliffwood.			
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Table of distribution of the

Page of this work.	Species.	Marthas Vineyard.			Block Island.			Long Island.							
		Chappaquiddick.	Nashaquitsa.	Gay Head.	Balls Point.	Southeast Point.	Black Rock Point.	Montauk Point.	Eatons Neck.	Little Neck (Northport Harbor).	Lloyd Neck.	Cold Spring.	Center Island.	Oak Neck.
103	Diospyros primæva Heer			+										
103	Diospyros apiculata Lesq.?			+										
104	Diospyros provecta Vel	+		+										
104	Diospyros pseudoanceps Lesq													
104	Diospyros prodromus Heer?													
105	* Periploca cretacea n. sp			+										
105	Viburnum Hollickii Berry										+			
105	Viburnum integrifolium Newb													
106	Dewalquea grönlandica Heer?													
106	Dewalquea insignis Hos. and v. d. Marck?													
106	Premnophyllum trigonum Vel			+										
106	* Phyllites poinsettioides Hollick													
107	Williamsonia problematica (Newb.) Ward			+										
107	* Williamsonia Riesii Hollick													
107	* Strobilites perplexus n. sp			+										
108	Tricarpellites striatus Newb			+										
108	* Tricalycites major Hollick		+	+										
109	Tricalycites papyraceus Newb	+			+						+			
109	* Calycites obovatus n. sp		+											
109	* Calycites alatus Hollick							+						
110	* Carpolithus euonymoides n. sp													
110	* Carpolithus vaccinioides n. sp													
110	Carpolithus floribundus Newb			+										
110	Carpolithus hirsutus Newb			+										
111	Carpolithus sp			+										
111	Carpolithus sp													
111	Carpolithus sp													
111	Carpolithus sp													
111	Carpolithus sp													
111	Carpolithus sp													
112	Rhizomorphs													
	Total number of species, 222	10	13	103	3	2	11	1	1	8	7	1	2	6

species described in this work—Continued.

Long Island.						Staten Island.						New Jersey.							
Dosoris Island.	Glen Cove.	Sea Cliff.	Mott Point (Manhasset Neck).	Elm Point (Great Neck).	Brooklyn.	Arrochar.	Princess Bay.	Richmond Valley.	Tottenville.	Kreischerville.	Green Ridge.	Sayreville.	Woodbridge.	South Amboy.	Morgans.	Cliffwood.	Dakota group.	Greenland.	Europe.
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2	67	12	6	4	3	6	5	1	36	30	1	11	49	15	6	42	58	54	37

PLATES.

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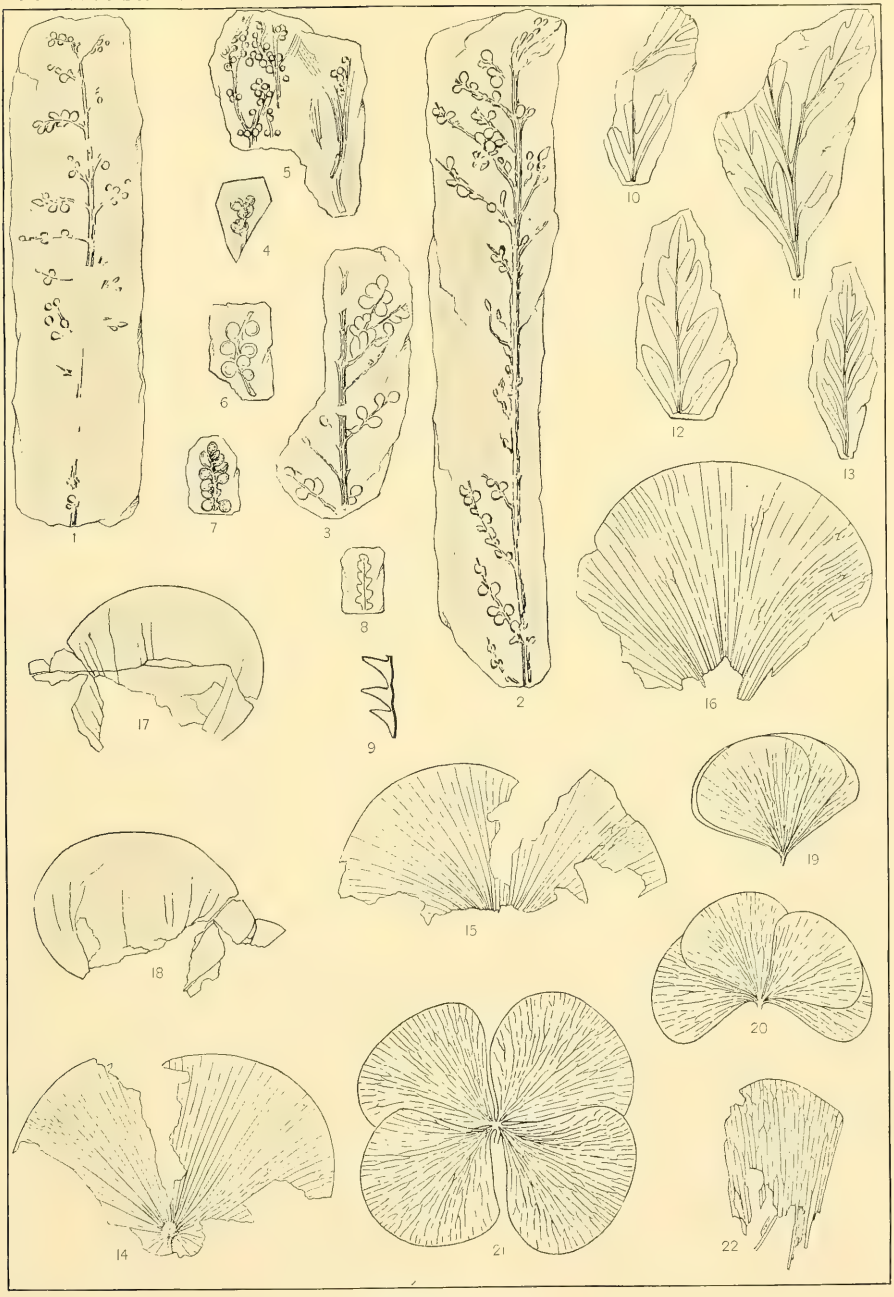

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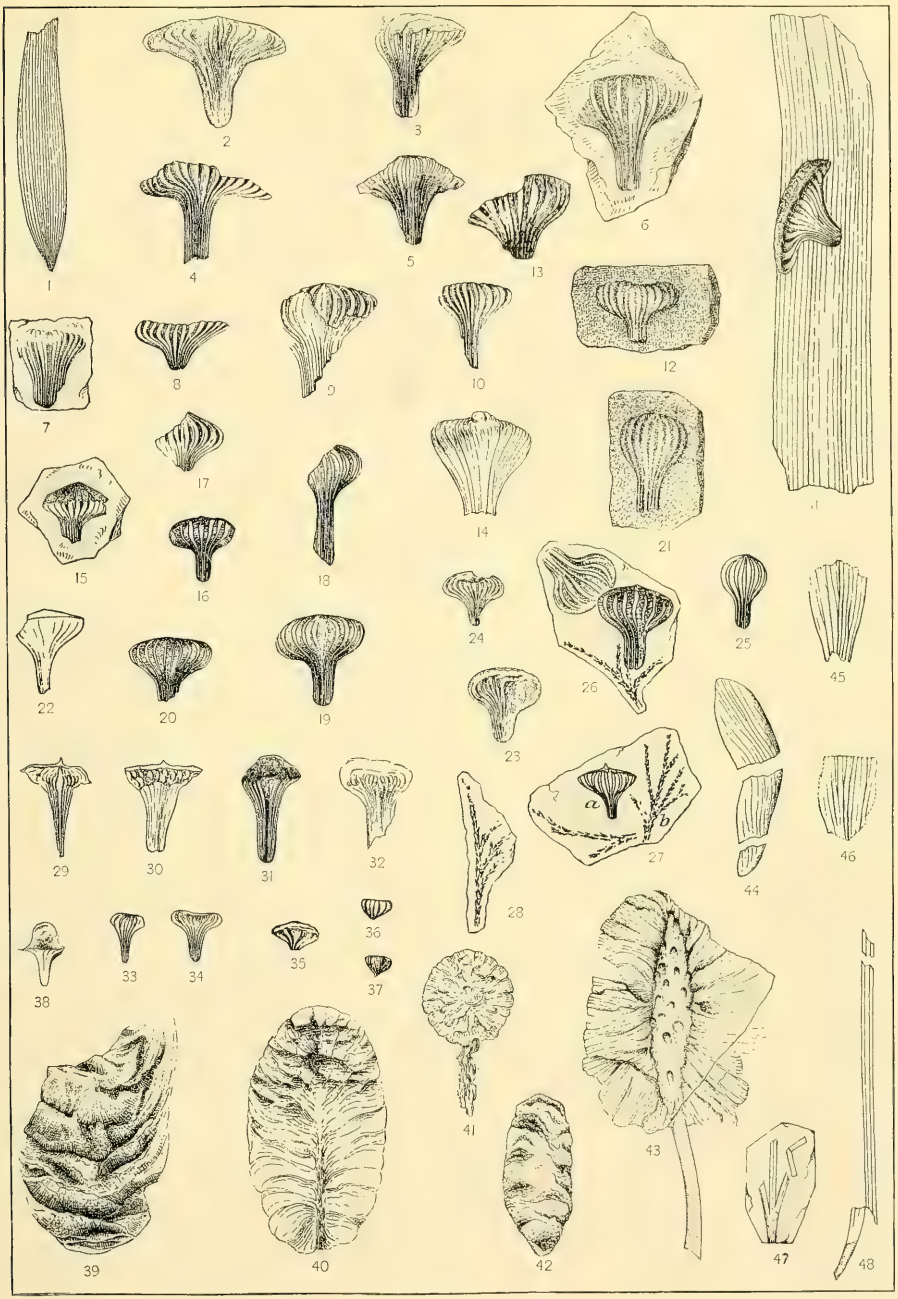

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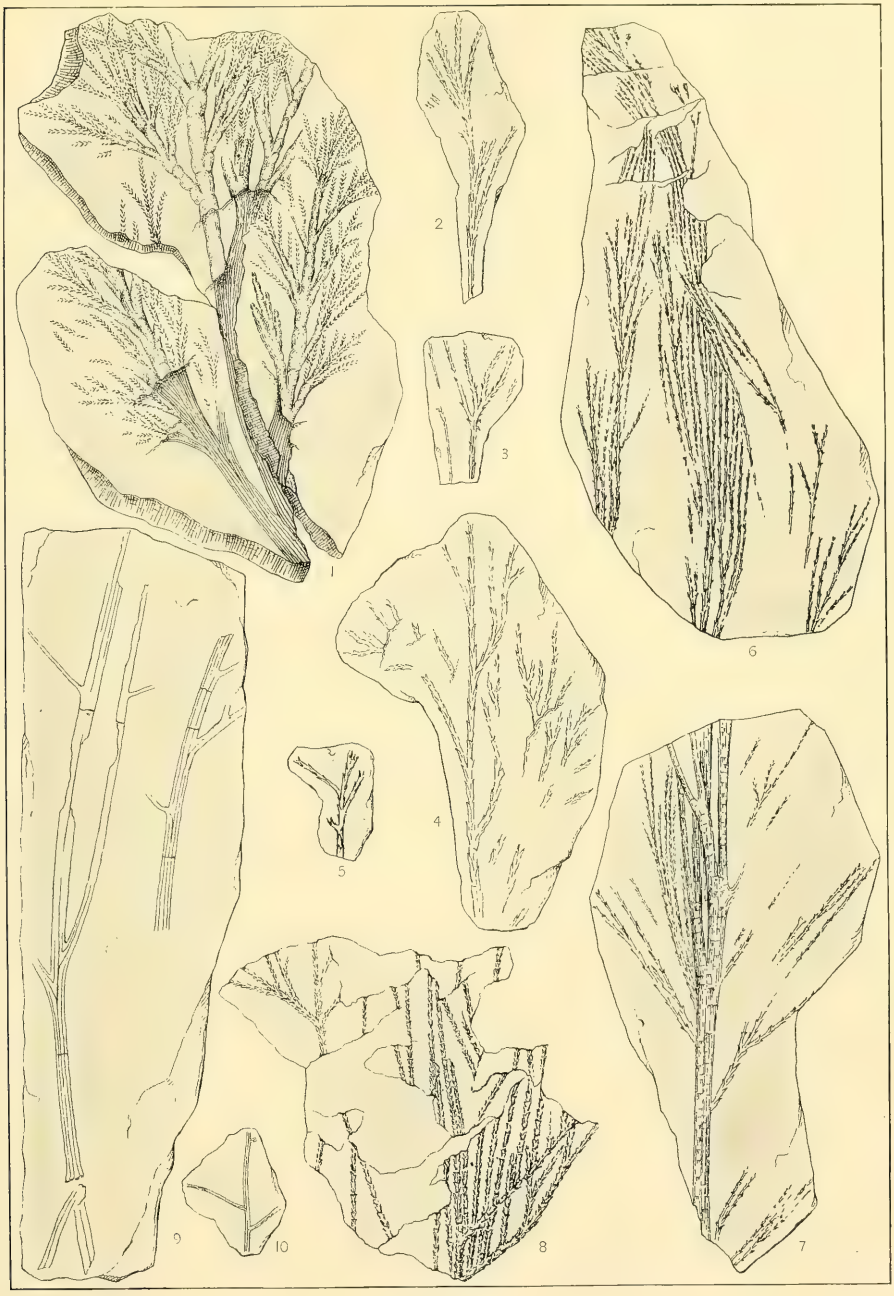

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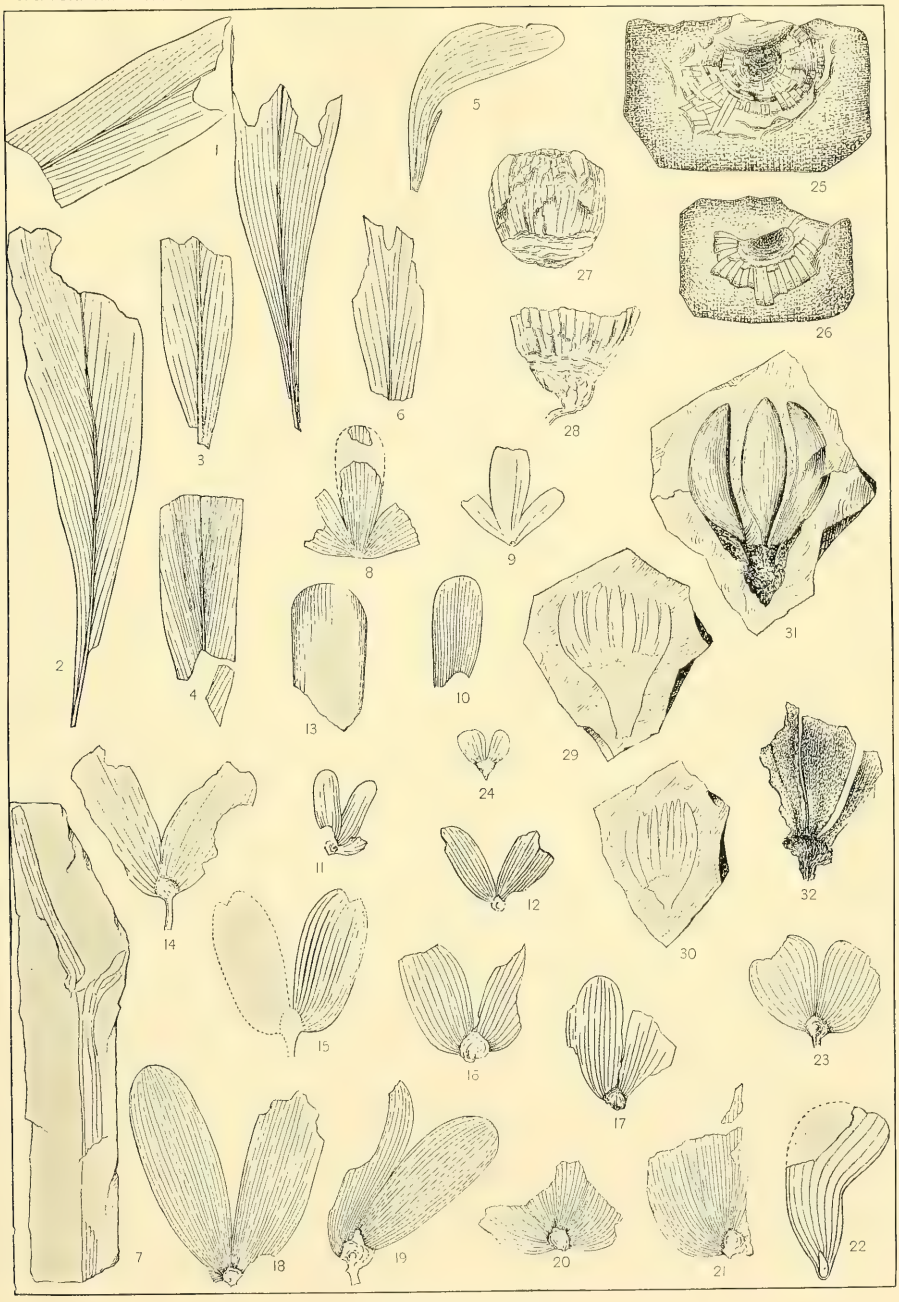

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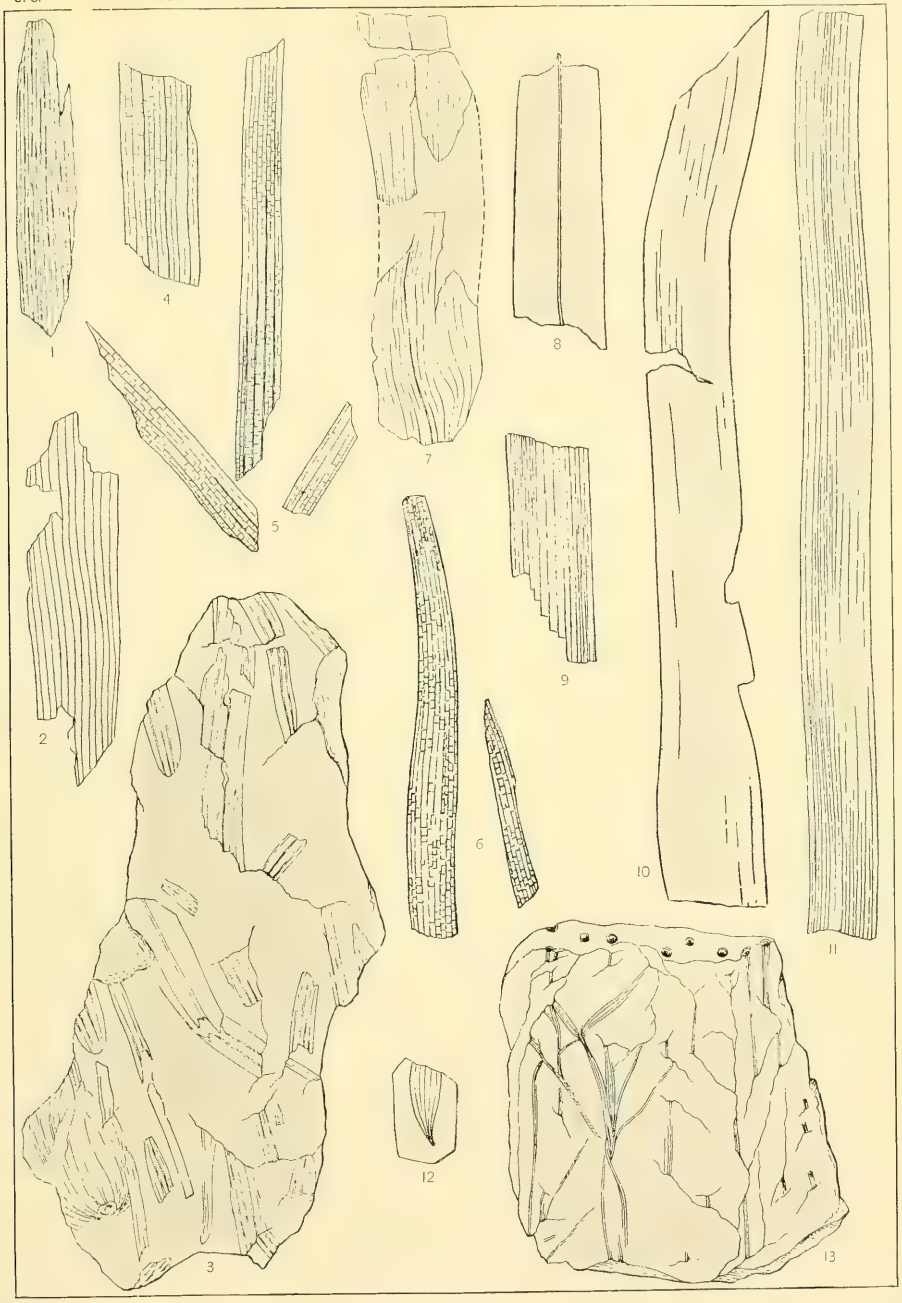

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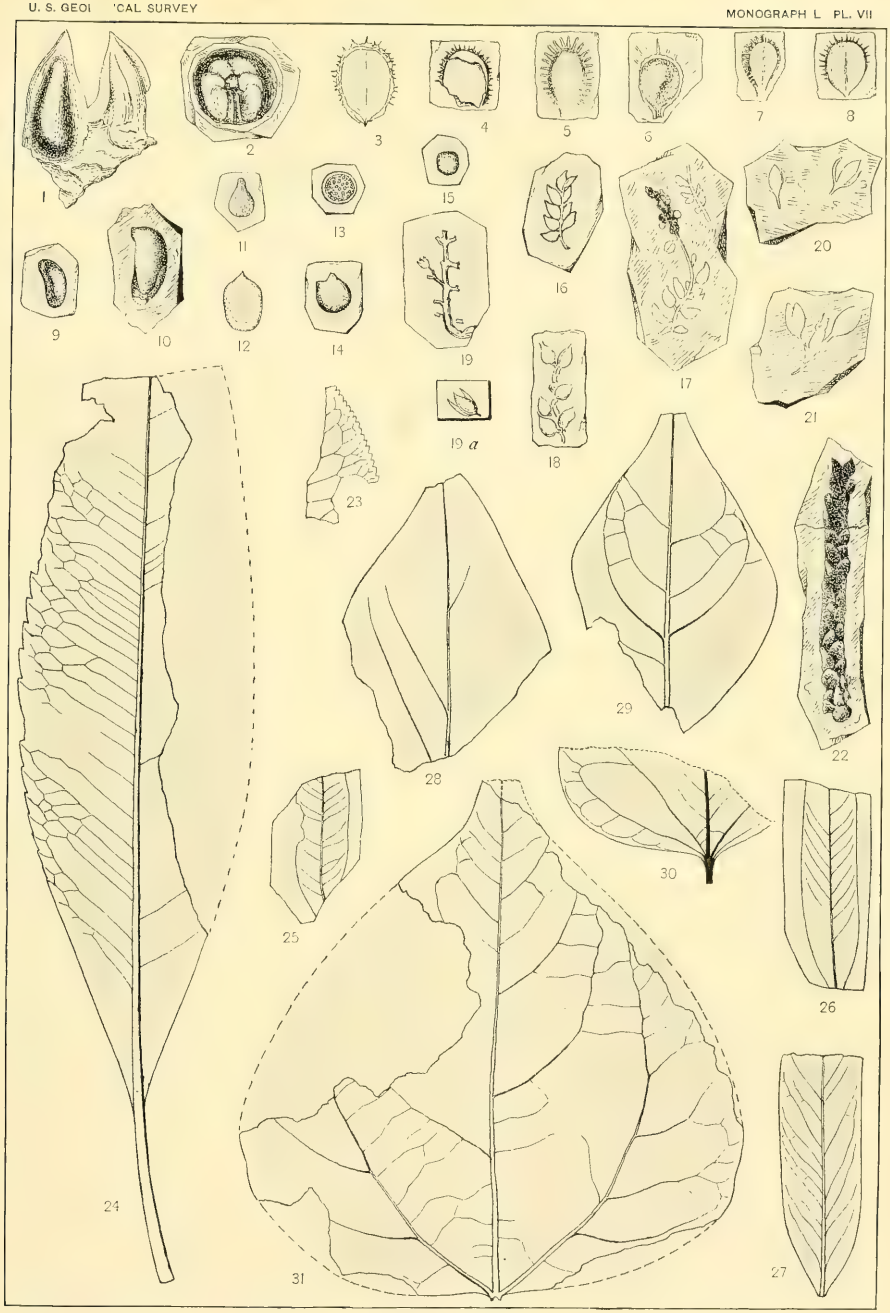

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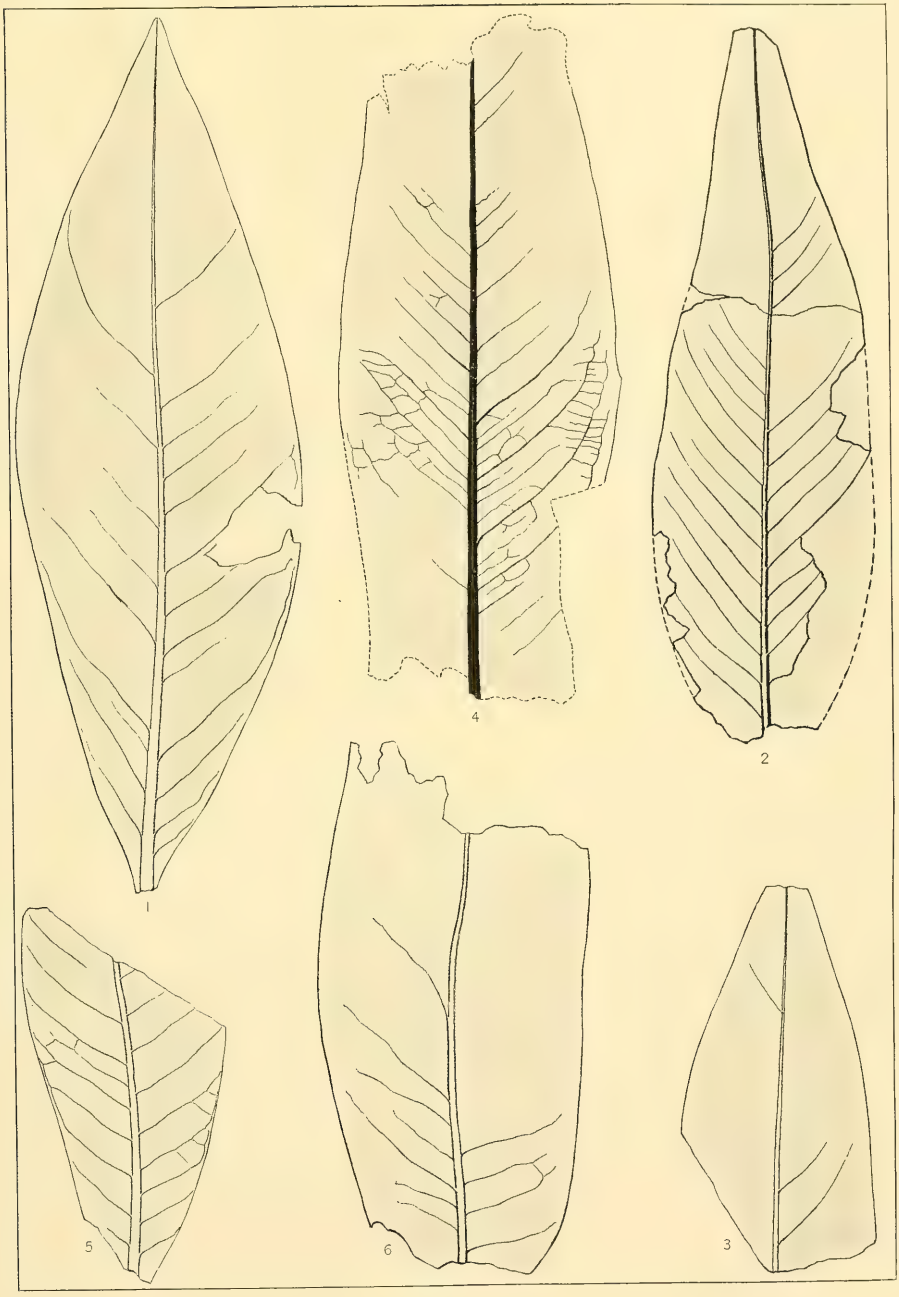

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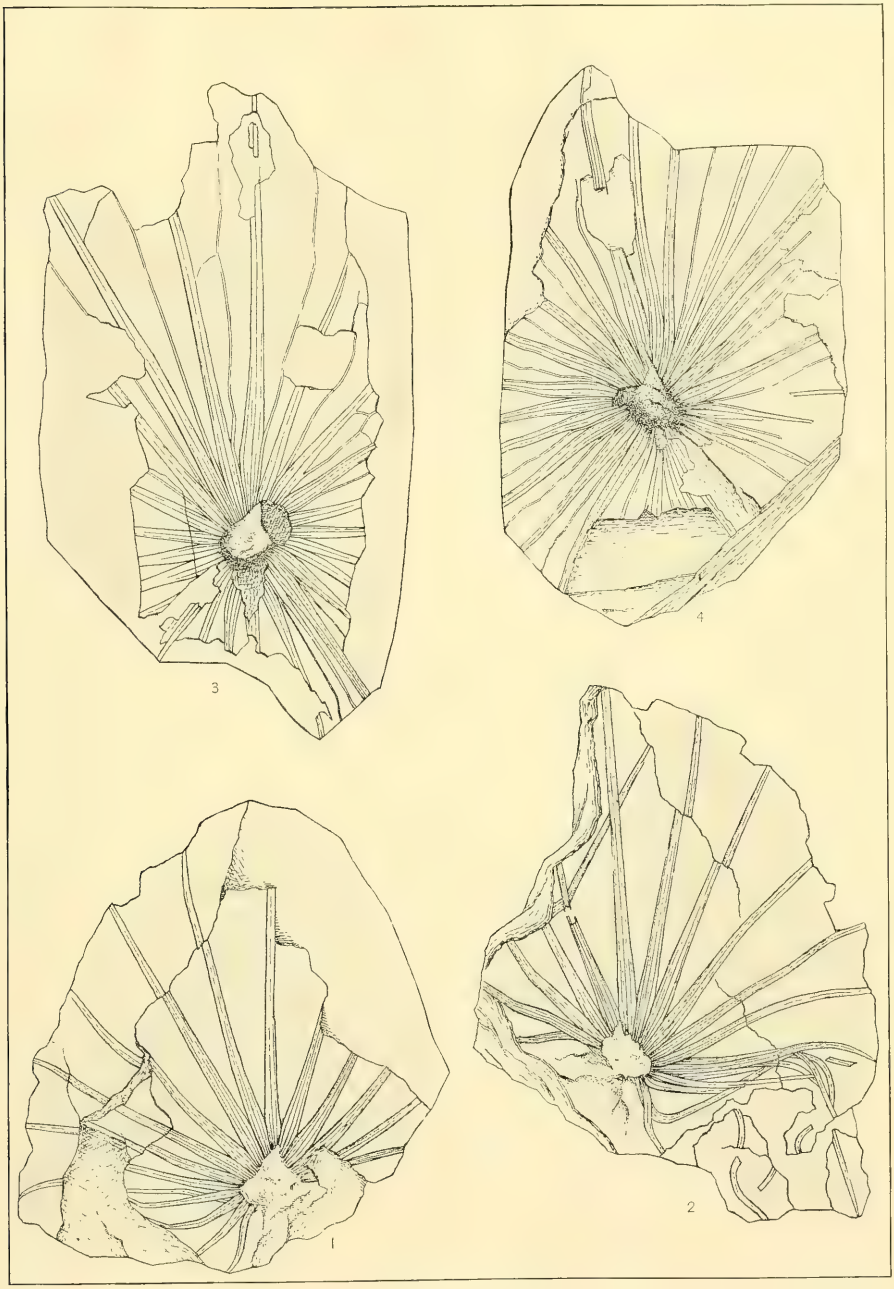

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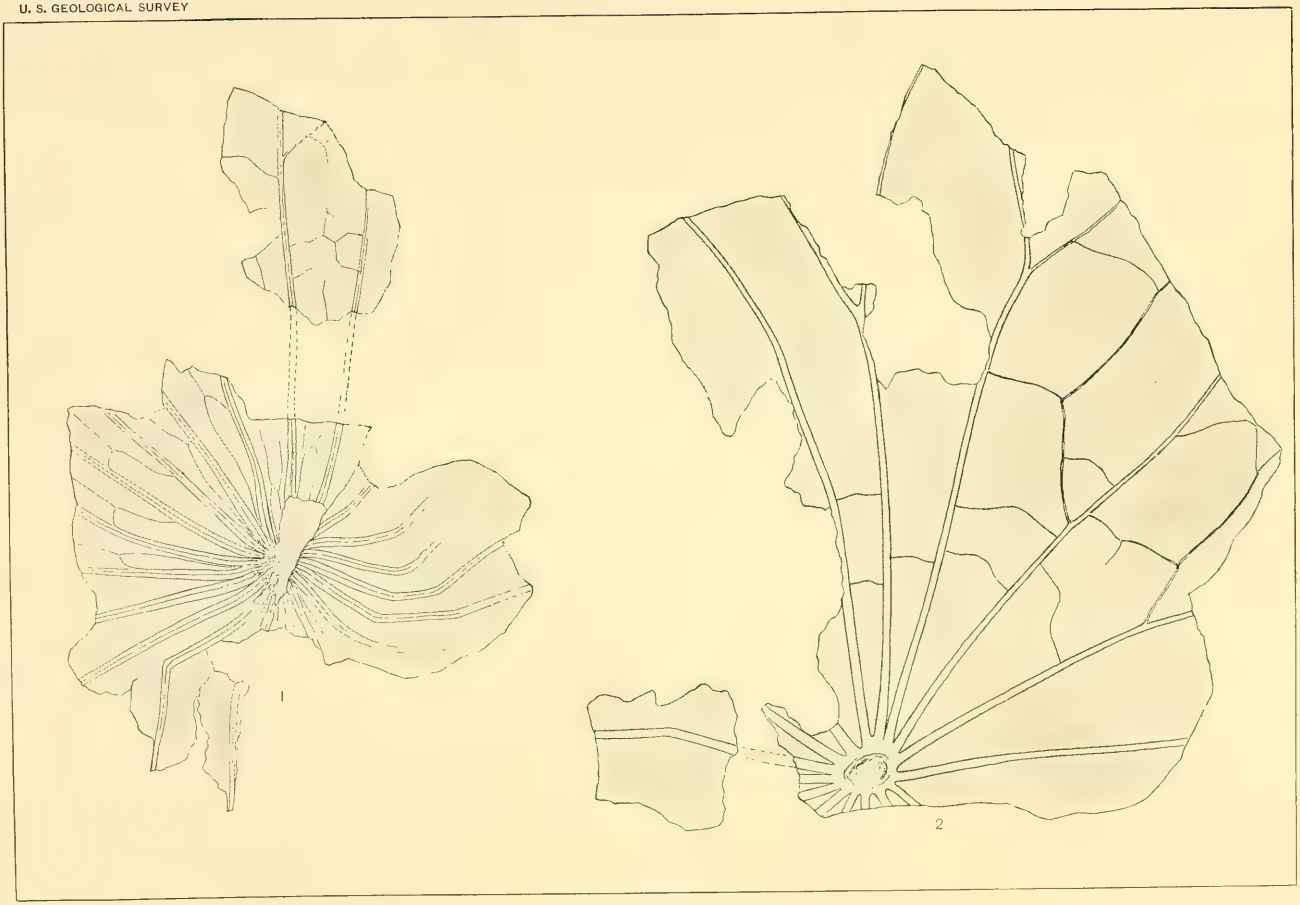

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PLATE XV.

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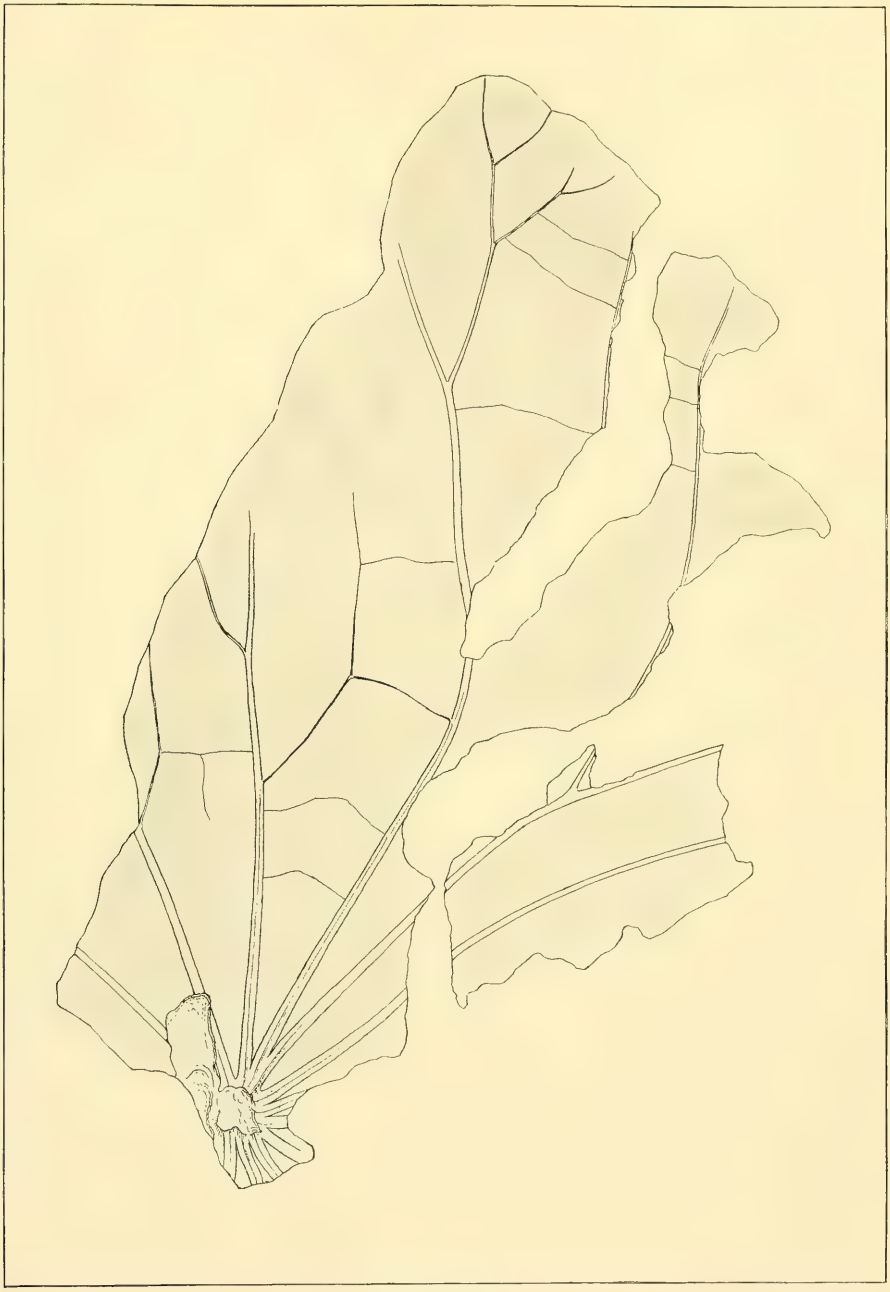

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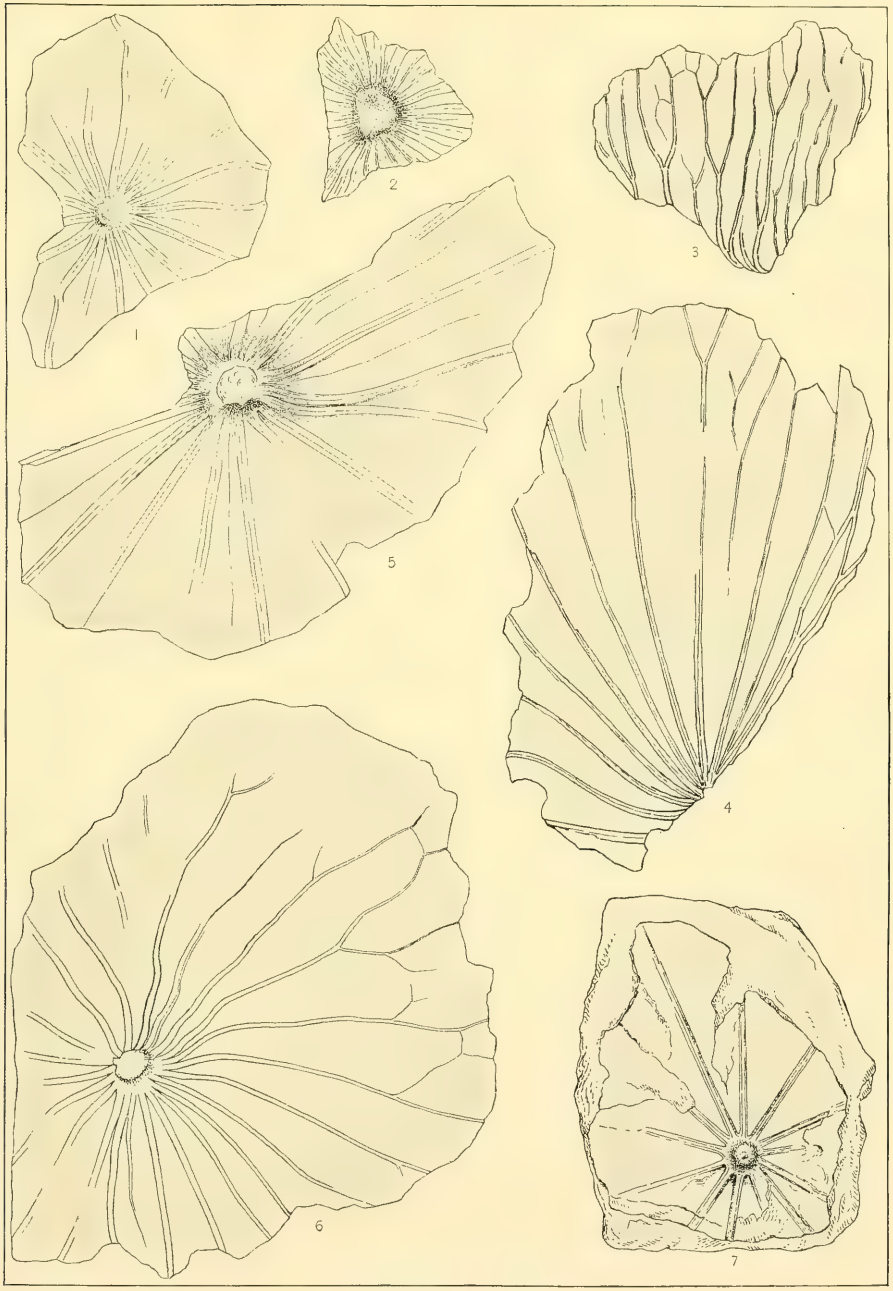

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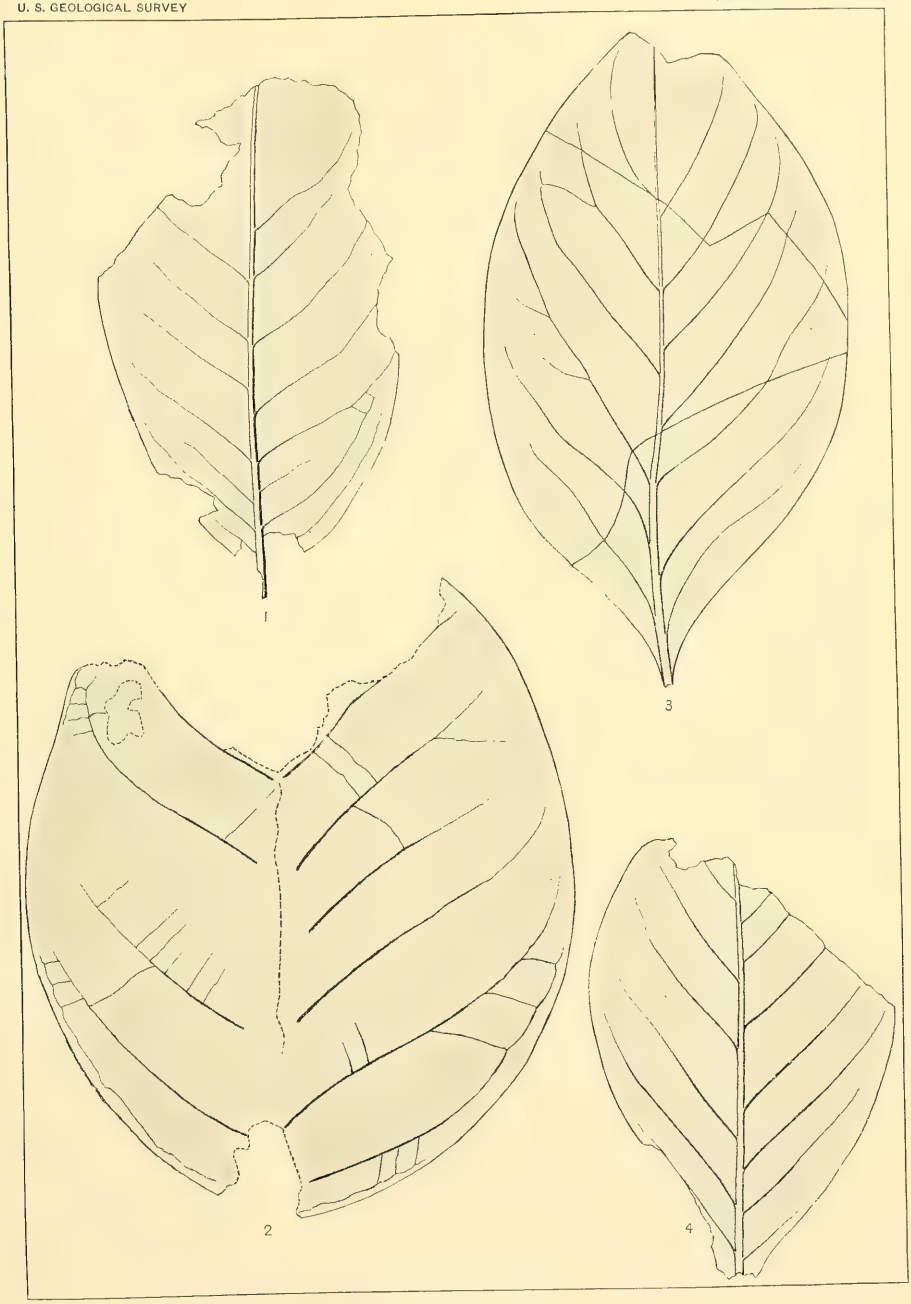

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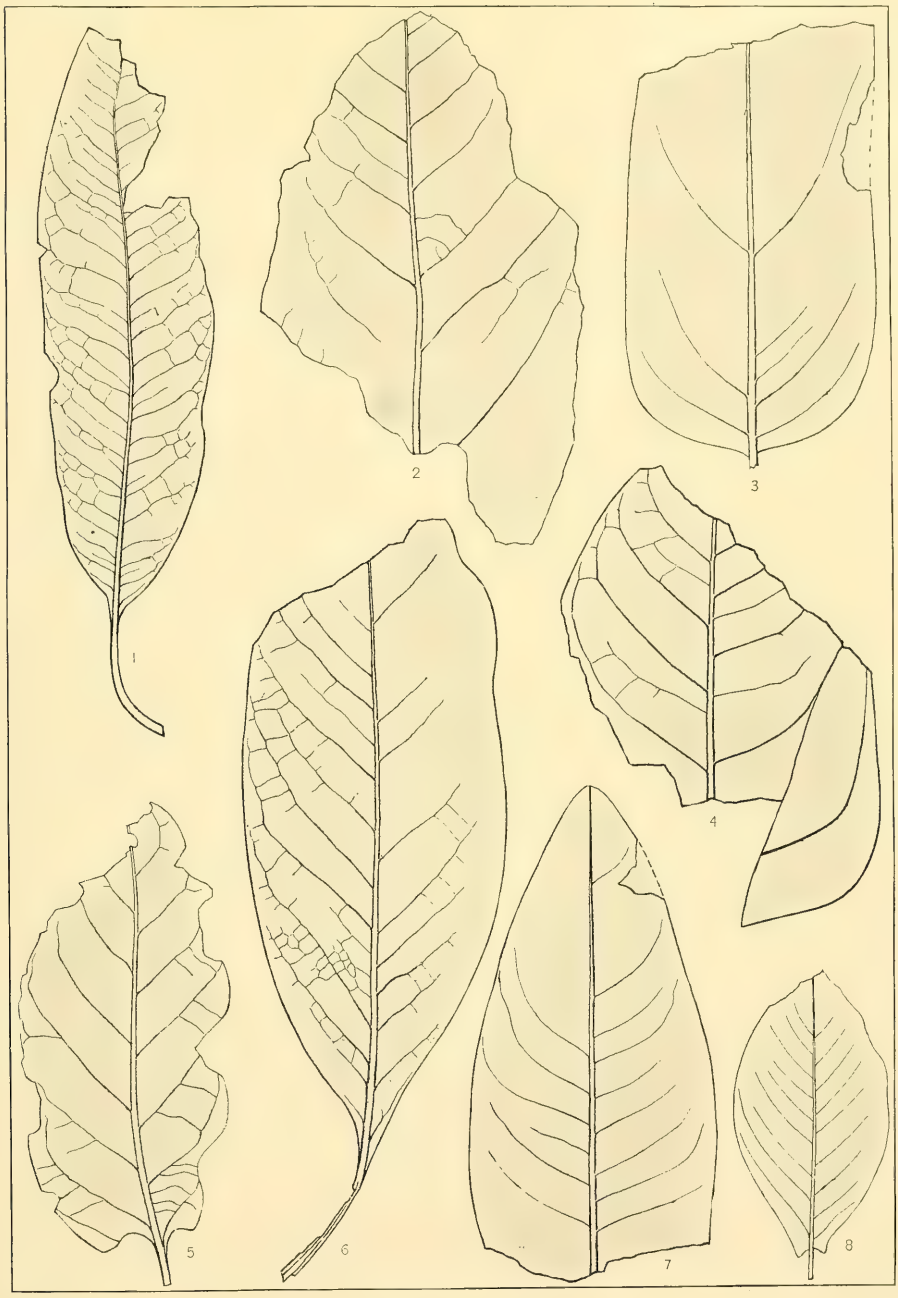

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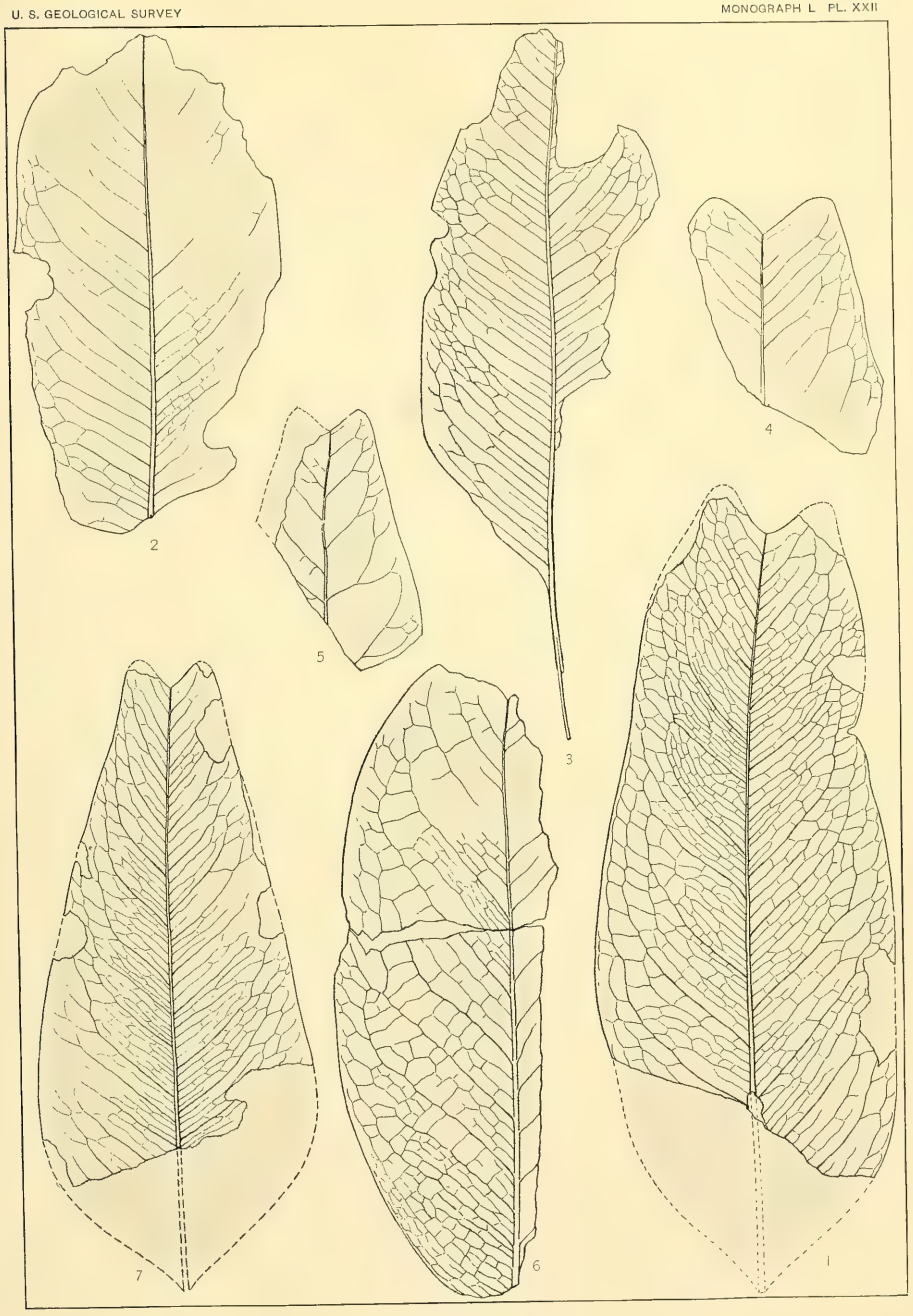

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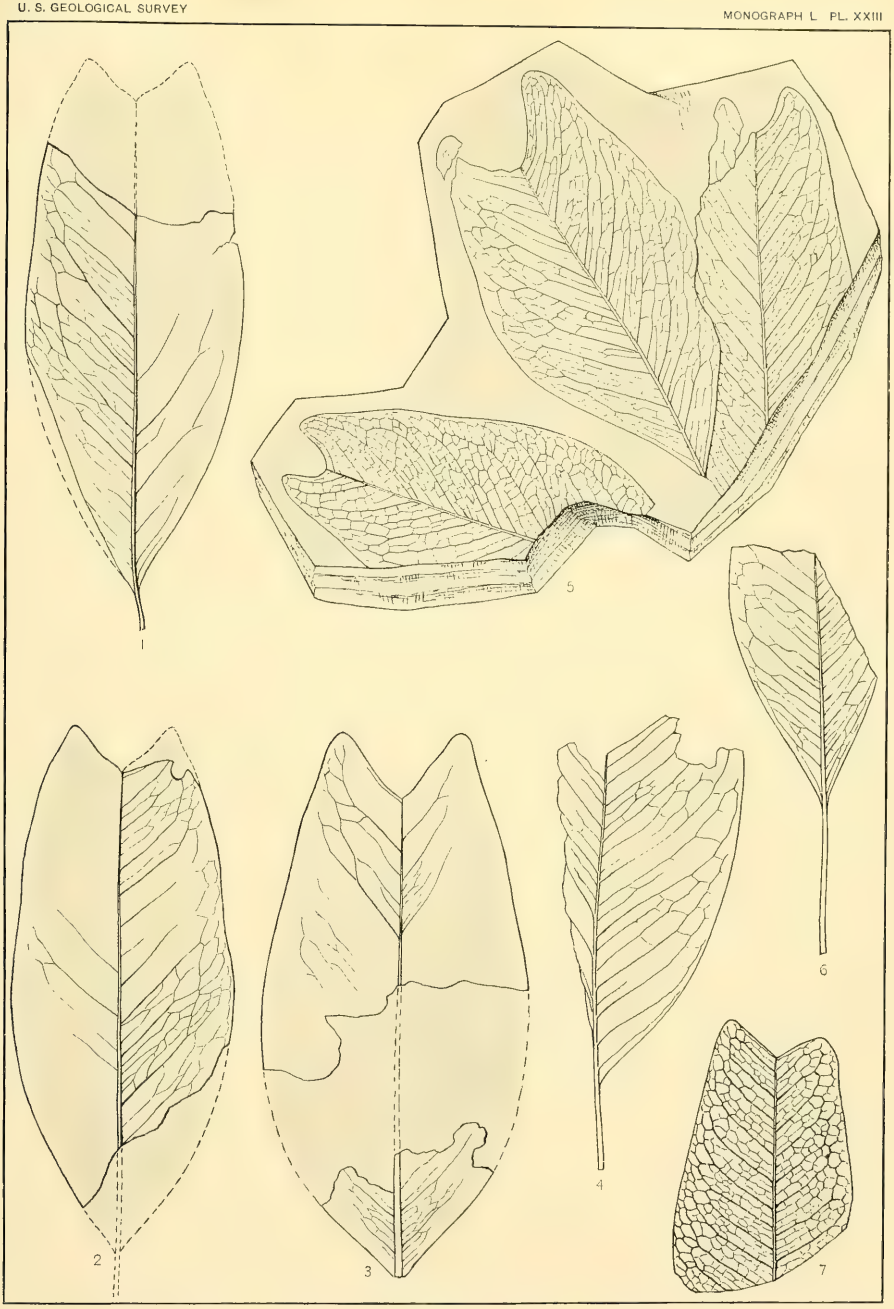

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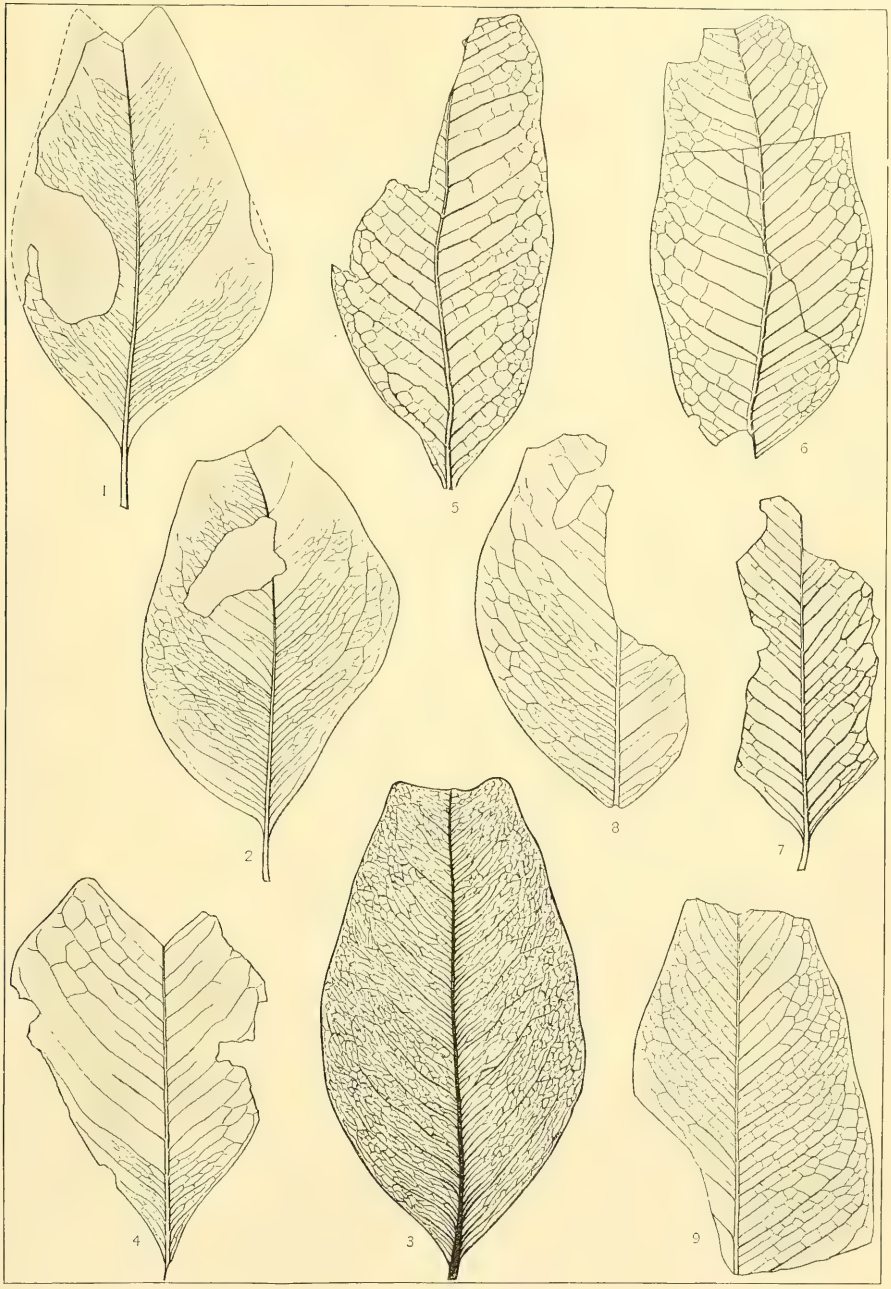

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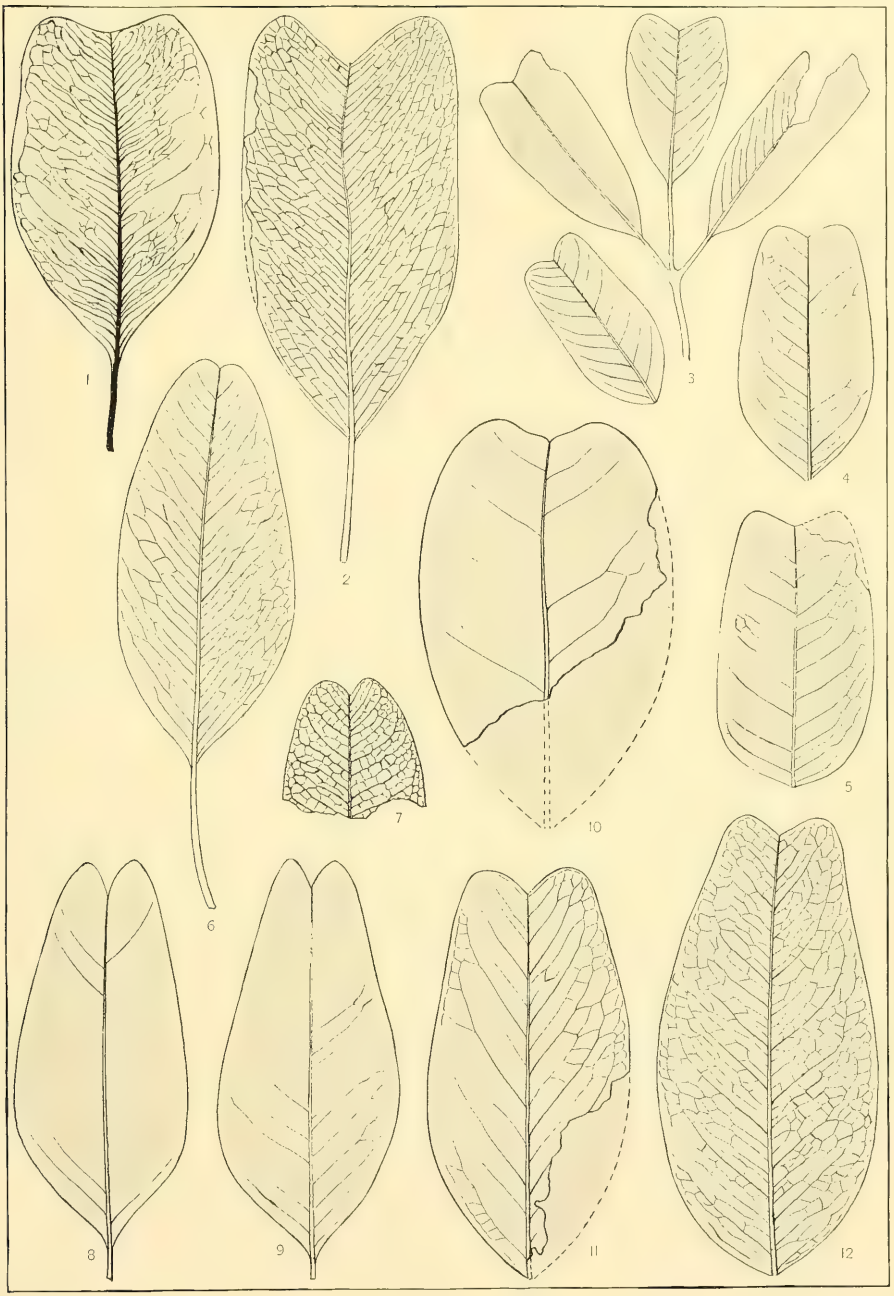

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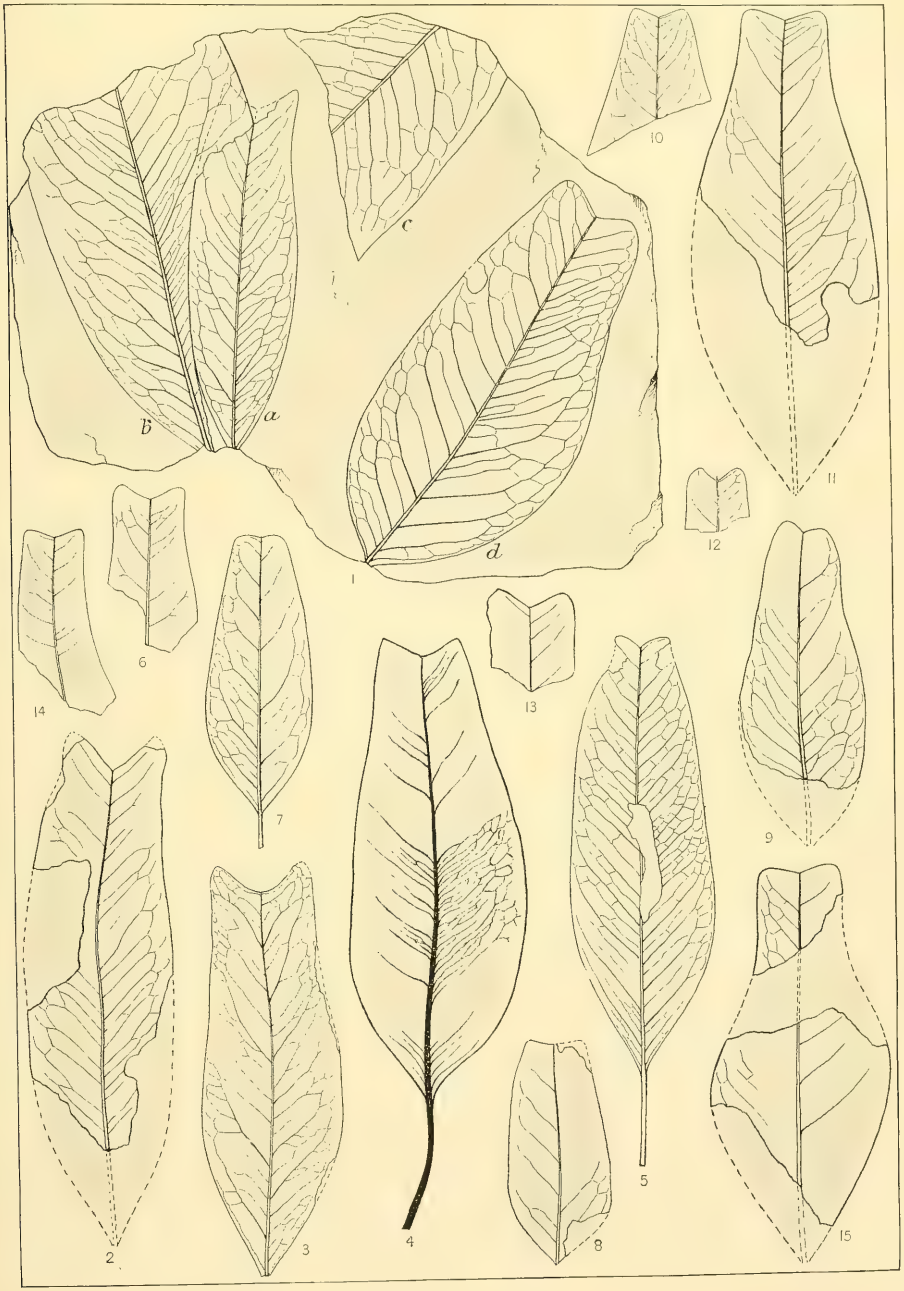

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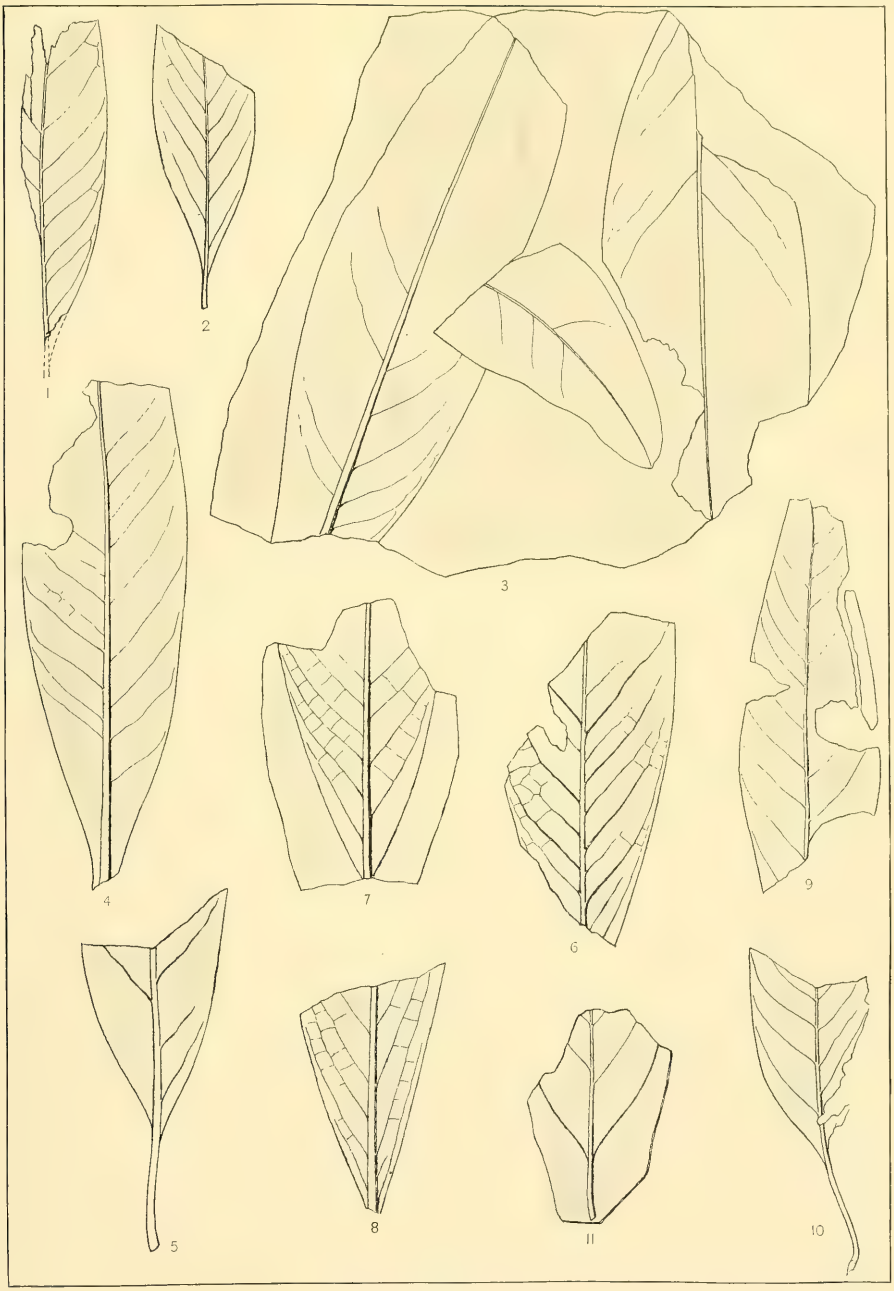

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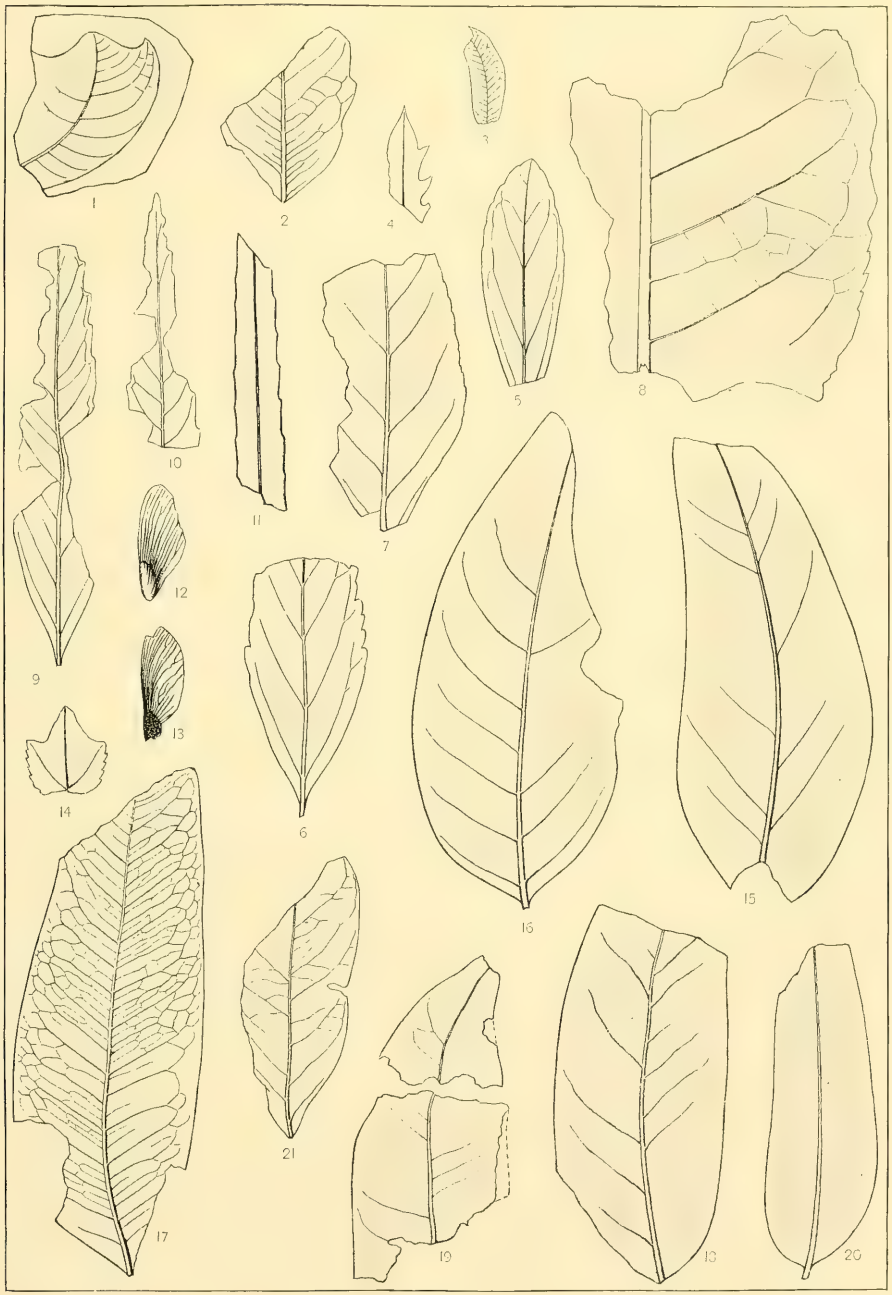

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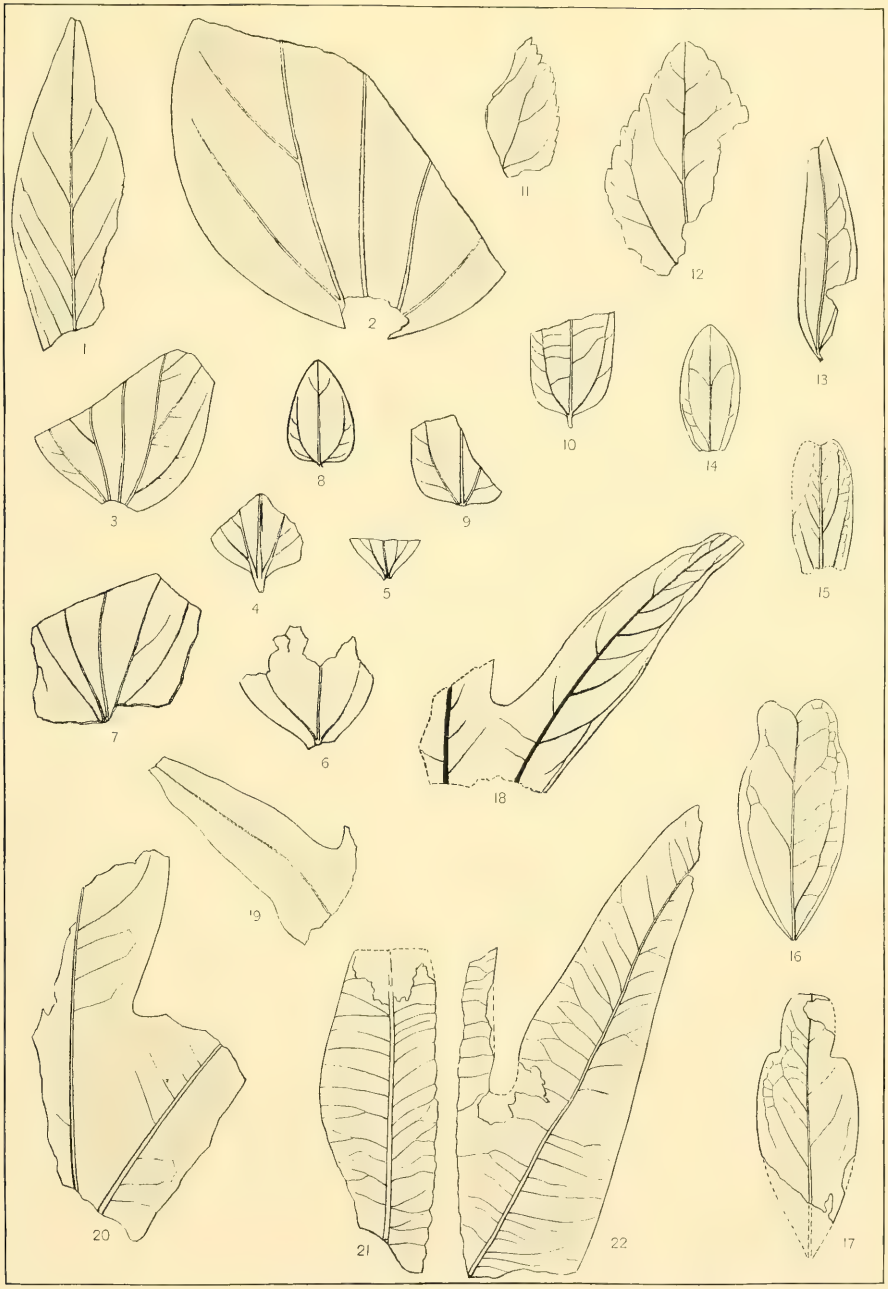

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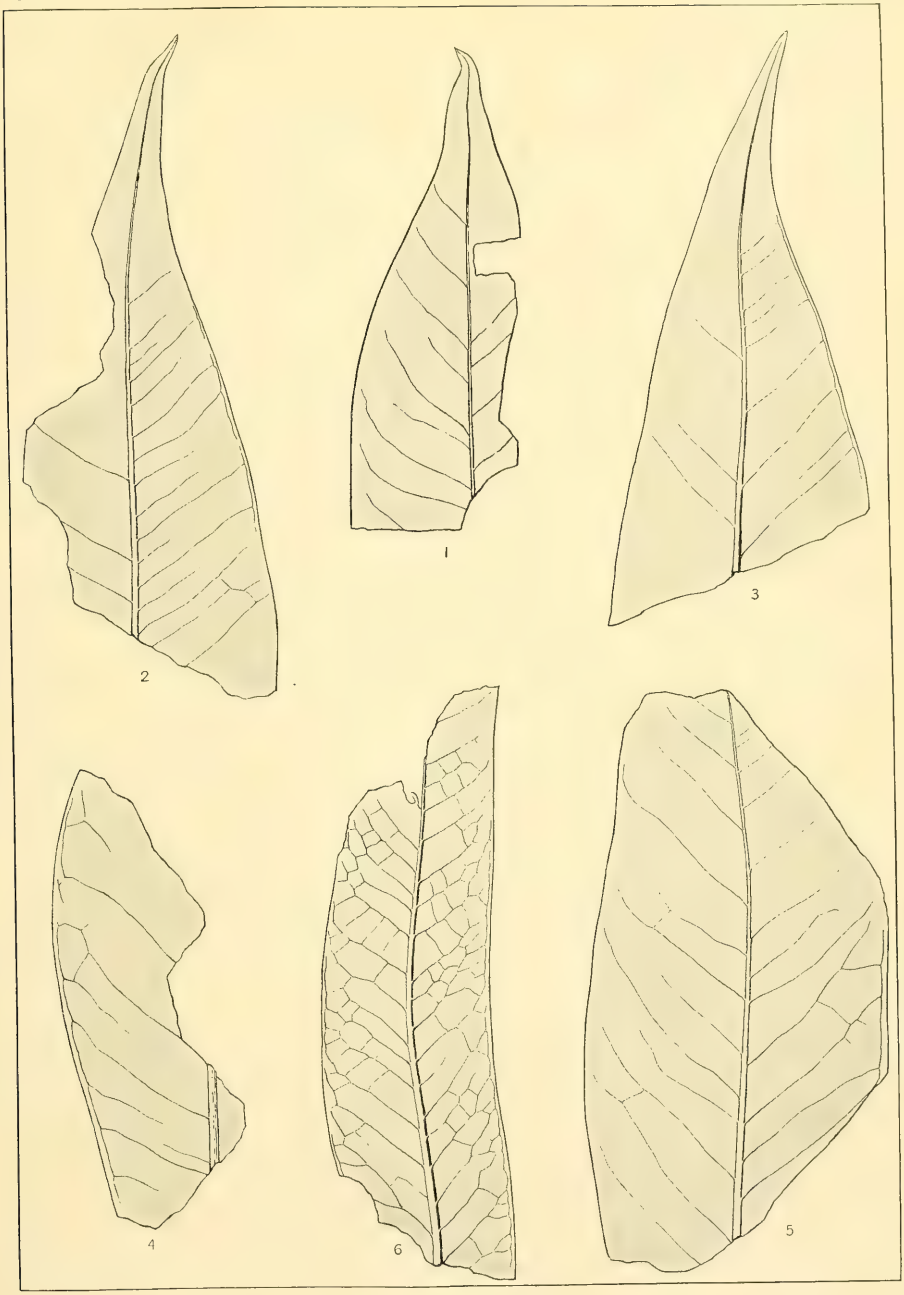

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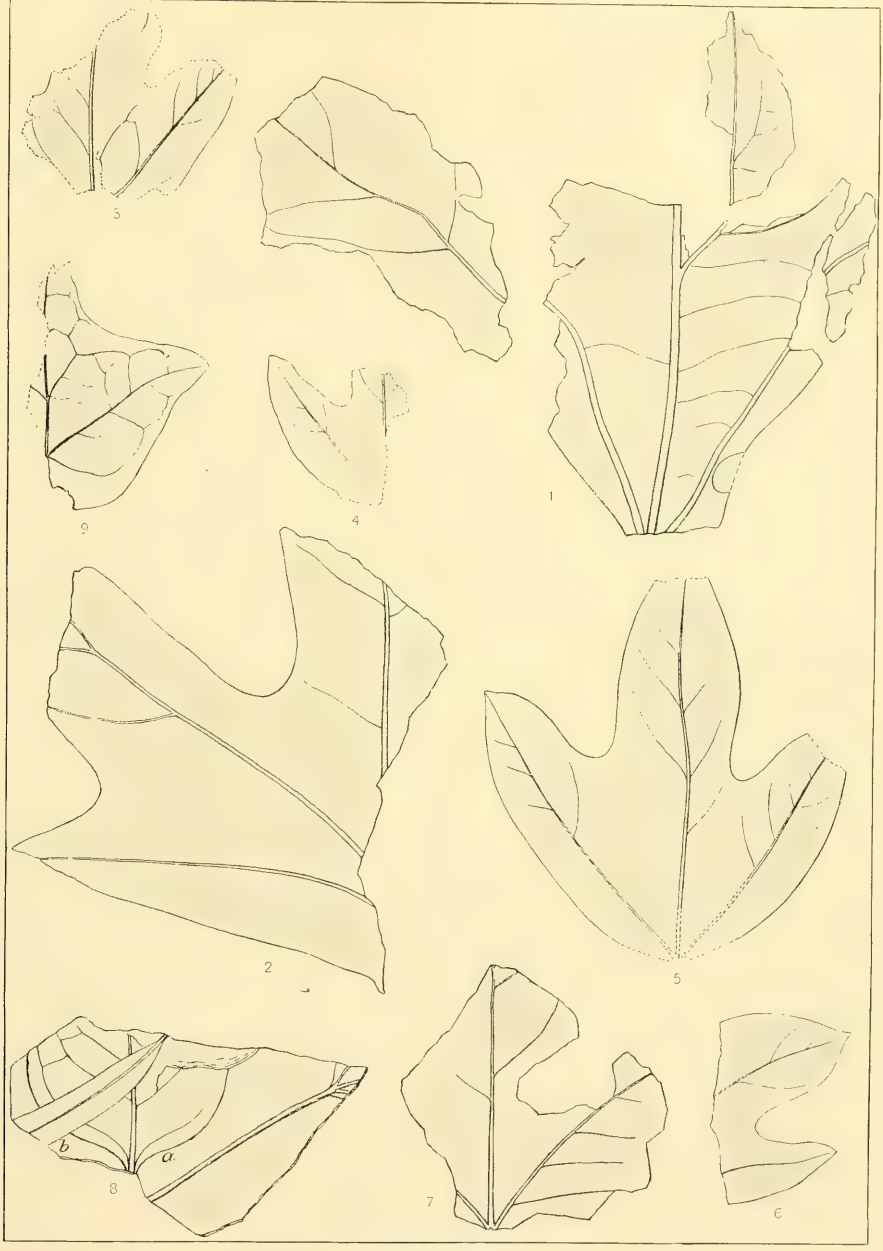

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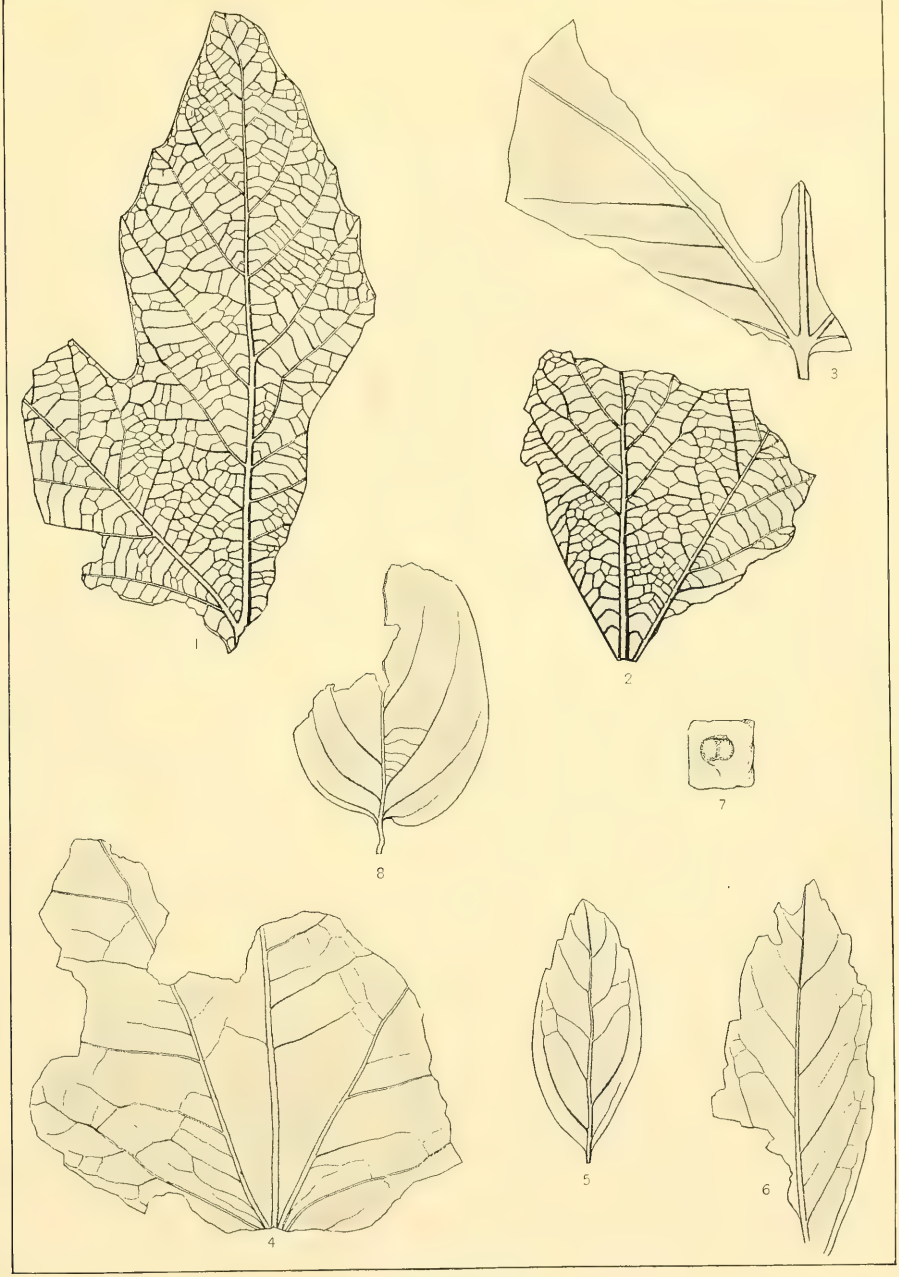

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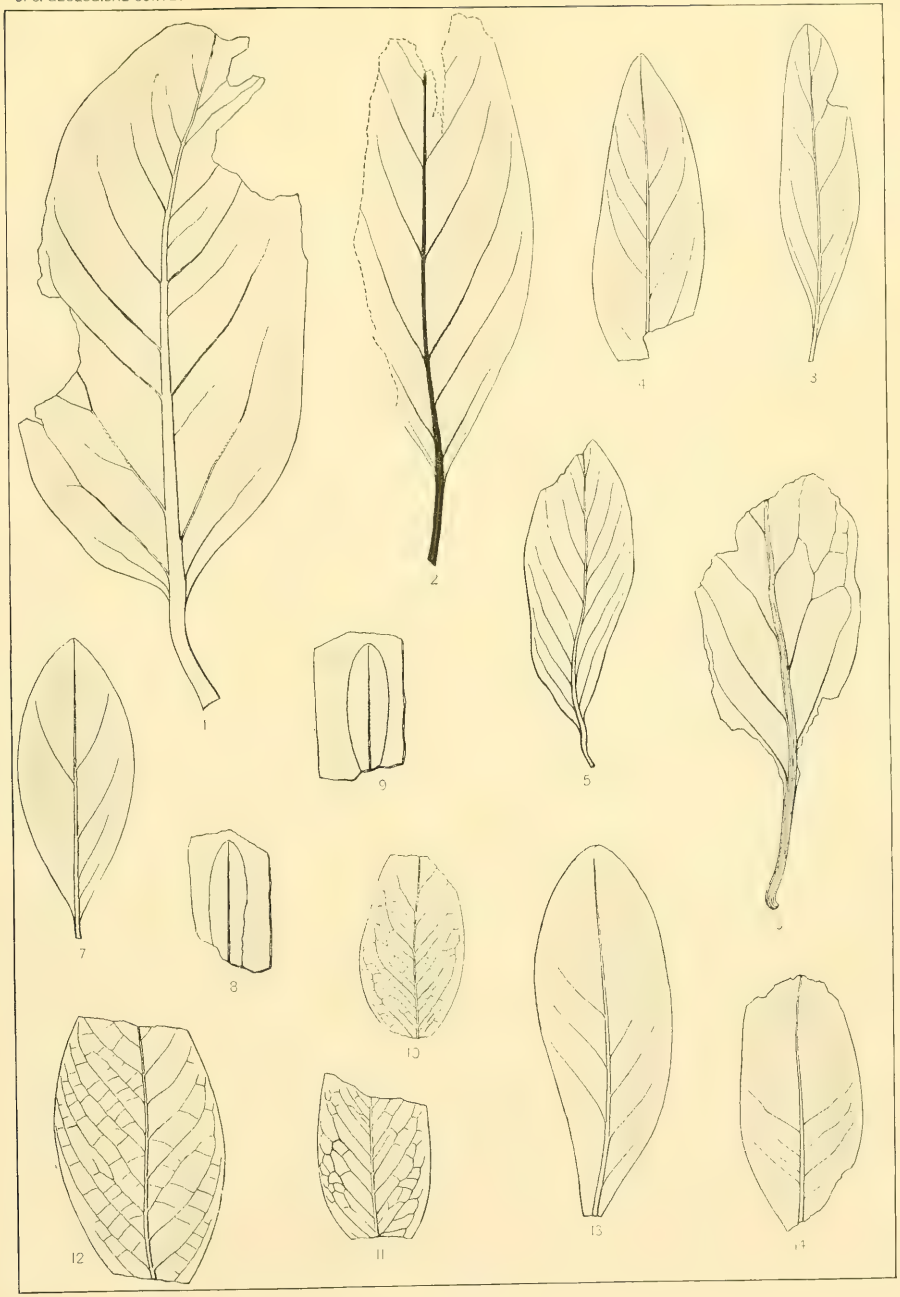

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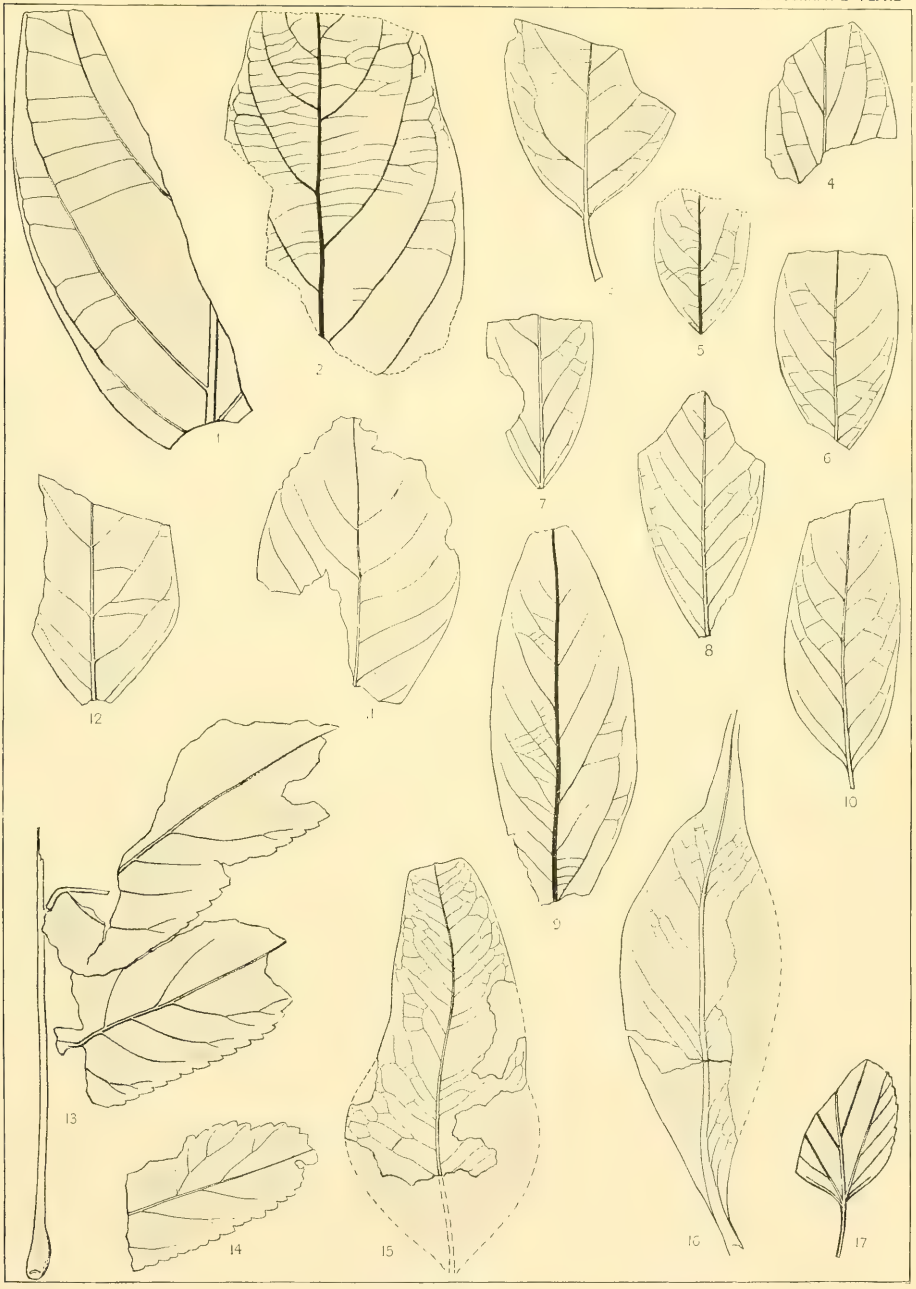

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I. Lake Bonneville, by G. K. Gilbert. 1890. 4°. xx, 438 pp., 51 pls., 1 map. Price, $1.50. (Out of stock.)

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